MAINTENANCE
and
OPERATION
of
AUTO-LITE
ELECTRICAL EQUIPMENT

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Parts and Service Division

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Complete technical information on all Auto-Lite equipment is included in the Service Manual Binder which is in the possession of every Auto-Lite Service Station.

Should additional information be required on any of the equipment covered in this manual or on any Auto-Lite unit not covered in this book it can be obtained from any Official Auto-Lite Service Station.

THE ELECTRIC AUTO-LITE COMPANY

PARTS AND SERVICE DIVISION

TOLEDO, OHIO, U.S.A.

SERVICE TOOLS

In order to meet the demands for accurate results automotive service men must be skilled in the art of measurement. This includes the use of the following essential service station tools.

1. Voltmeter	7. Vacuum Gauge
2. Ammeter	8. Compression Gauge
3. Ohmeter	9. Coil Tester
4. Timing Light	10. Micrometers
5. Gap Gauges	11. Distributor Test Fixture
6. Feeler Gauges	12. Condenser Tester

Several of these units have been developed to Auto-Lite specifications as fine precision instruments while others may be obtained from several dependable sources.

In handling electrical measuring instruments it should be remembered that they are extremely sensitive and delicately balanced. They should not, therefore, be subjected to sudden shocks nor should they be subjected to excessive vibration. A stand such as illustrated in Figure 1 is comparatively easy to make and will eliminate the vibration they receive when placed on the car with the engine running.

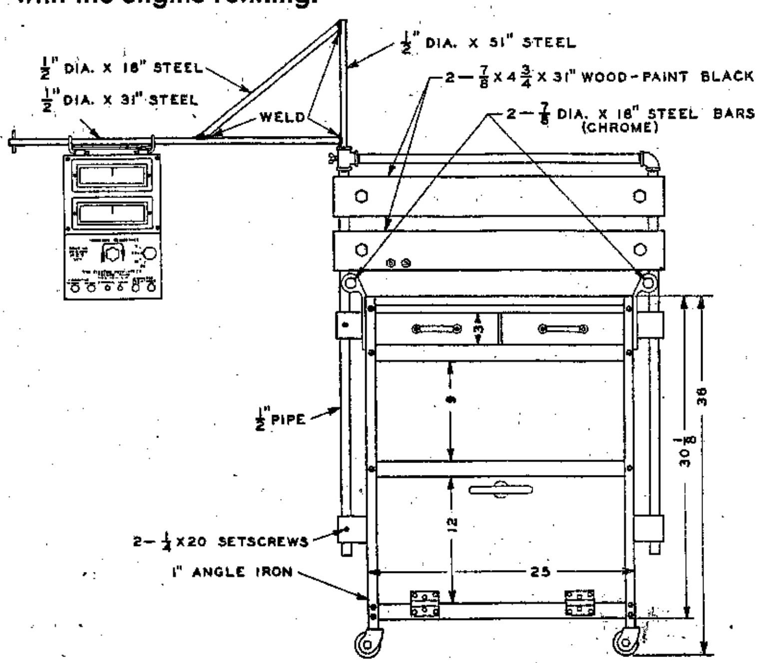


FIGURE 1

The following list includes a few of the many Service Tools that are available. Those included are the tools which are required for accurate adjustment service.

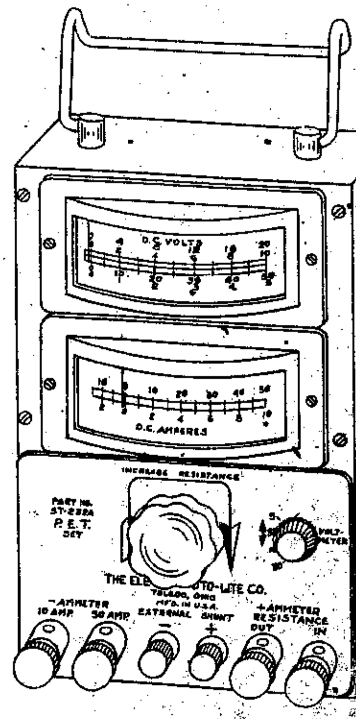


FIGURE 2

ST-232A PORTABLE ELECTRIC TESTER (P.E.T.)

This instrument (Figure 2) was developed for the use of Official Auto-Lite Service Stations so that they would have an instrument of the necessary accuracy and durability at low cost.

Both voltmeter and ammeter are of the horizontal type to obtain the longest possible scale so that indications may be read accurately.

The voltmeter has four ranges which are selected by a rotary switch mounted on the right hand side of the front face of the tester.

SERVICE TOOLS — Continued

0- 5 volt scale for testing high resistances and electrical devices operating at low voltages.

0-10 volt scale for general use on 6 volt circuits.

0-20 volt scale for general use on 12 volt circuits.

0-50 volt scale for general use on 24 and 32 volt circuits.

For the 0-10 volt scale there are 100 divisions so that each represents .1 volts. Accuracy of the voltmeter is held within 1% of all parts of the scale, except between 6 and 9 volts where it is held to ½% accuracy. This is necessary as this latter portion of the scale is the most commonly used in testing 6 volt circuits.

The ammeter has two scales:

3-0-10 ampere scale for testing low current draw.

15-0-50 ampere scale for general use in testing automotive circuits.

Depressed zero scales are built into the instrument to avoid the necessity of changing the ammeter connections to obtain negative readings such as the amperes discharge required to open circuit breakers.

The accuracy of the ammeter is held within 2% of full scale deflection.

A ⅛ ohm rheostat of 50 ampere capacity is included in this instrument for use in setting voltage to test specifications.

There are four current carrying binding posts on the instrument: The first one on the right hand side, marked "Resistance In," is connected to the rheostat and is in series with the positive terminal of the ammeter.

The second binding post, marked "Resistance Out" is a direct connection to the positive terminal of the ammeter without passing through the rheostat.

The third binding post is connected to the negative terminal of the ammeter for the 50 ampere scale.

The fourth binding post is connected to the negative ammeter terminal for the 10 ampere scale.

Two small binding posts are provided between the second and third current carrying binding posts for the use of external shunts. The following

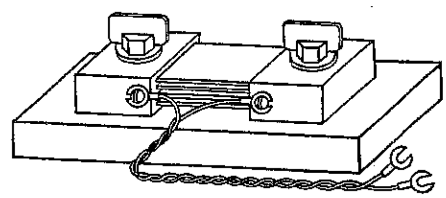


FIGURE 3

shunts (Figure 3) are available with calibrated leads for connections to the P.E.T. Set:

100 ampere capacity—Part Number ST-232A-2
200 ampere capacity—Part Number ST-232A-3
500 ampere capacity—Part Number ST-232A-1
1000 ampere capacity—Part Number ST-232A-4

The voltmeter leads are permanently attached to the instrument and are 27" long with alligator clips on the ends for ease in making connections. The positive lead is colored red and the negative lead is black.

Ammeter leads are No. 8 flexible cable 37" long and have pin terminals on one end for connecting to the current carrying binding posts and special clips on the other end. The positive lead is red and the negative black. The ammeter lead clips have a long tooth on each corner so that they may be securely connected to wires with screw holes in the terminals.

SERVICE TOOLS — Continued

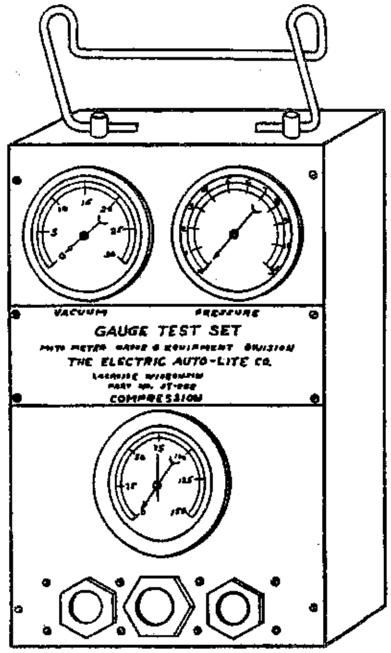


FIGURE 4

ST-262 V.C.P. TEST SET

This test unit (Figure 4) is a very compact set of gauges for general automotive testing.

The upper right hand gauge is a retard type pressure gauge with a range of from 0-10-30 pounds per square inch. It can be used for checking either fuel pump pressure or exhaust back pressure.

The upper left hand gauge is a vacuum gauge with a range of 0 - 30″ of vacuum. This gauge is used to check intake manifold vacuum as well as checking the spark advance calibration of vacuum type distributors.

The lower gauge is a compression gauge. It has a range of 0 - 150 pounds per square inch. It is used for testing engine compression pressure.

Complete operating instructions are included in a booklet shipped with each instrument.

ST-265 CONDENSER TESTER

This tester (Figure 5) is a single meter instrument designed to provide three tests for automo-

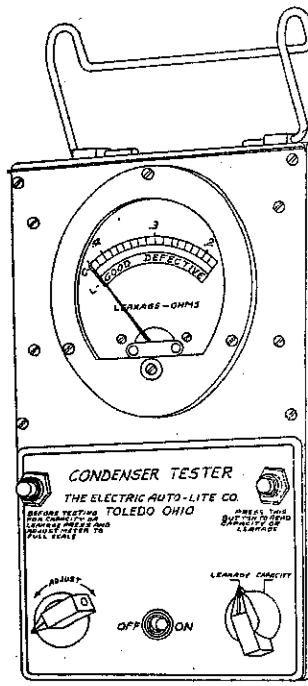


FIGURE 5

tive condensers: leakage, capacity in microfarads and 500 volt insulation breakdown test. With it condensers can be tested either on or off the vehicle.

Shipped with each tester is an instruction booklet which gives complete details as to its usage.

ST-270 UNIVERSAL HORN TEST BRACKET

To properly adjust Auto-Lite horns it is neces-

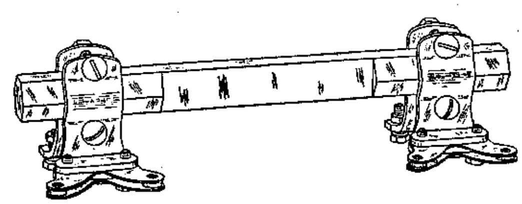


FIGURE 6

sary that they be mounted on a properly designed test bracket (Figure 6.) Do not hold any horn in a vise clamped by the horn flange as this may crack the diaphragm.

ST-272 HORN FEELER GAUGE SET

These gauges, illustrated in Figure 7, are for checking the air gap between the armature and

SERVICE TOOLS — Continued

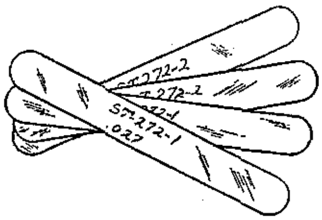


FIGURE 7

core. The set includes two each of ST-272-1 .027 inch thick gauge and ST-272-2 .040 inch thick gauge.

ST-281 VR REGULATOR GAUGES (Figure 8)

This list includes all necessary gauges for the

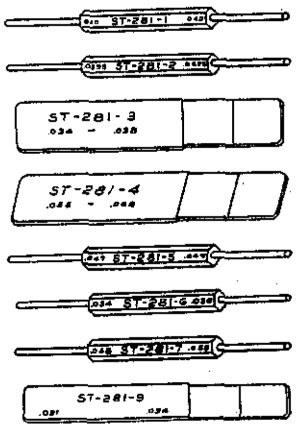


FIGURE 8

adjusting and setting the air gaps of the TC and VR type regulators, namely:

- ST-281-1 Armature—Core Air Gap Gauge— .040"—.042"
- ST-281-2 Armature—Core Air Gap Gauge— .0595"—.0625"
- ST-281-3 C.B. Armature — Core Air Gap— .034"—.038"
- ST-281-4 C.B. Armature — Core Air Gap— .055"—.062"
- ST-281-5 Armature—Core Air Gap Gauge— .047"—.049"
- ST-281-6 Armature—Core Air Gap Gauge— .034"—.038"
- ST-281-7 Armature—Core Air Gap Gauge— .048"—.051"
- ST-281-9 C.B. Armature — Core Air Gap— .031"—.034"

ST-282 VR REGULATOR ADJUSTING TOOL (Figure 9)

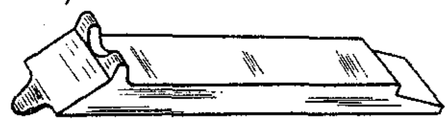


FIGURE 9

This tool is designed for adjusting the air gap of vibrating type regulators.

ST-283 REGULATOR SPRING TENSION ADJUSTING TOOL (Figure 10)

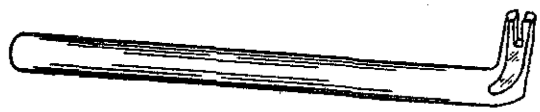


FIGURE 10

This tool is used to adjust the armature spring tension on all two charge and small type vibrating voltage regulators.

ST-284 OHMETER

This meter (Figure 11) is a self-contained unit

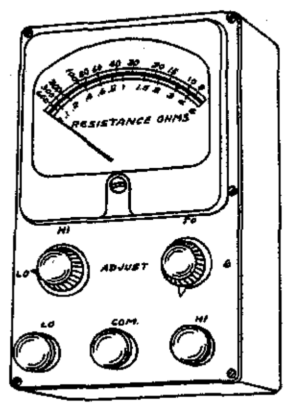


FIGURE 11

used to check the resistance of automotive electrical windings. Instructions for its correct usage are attached to each meter.

There are two scale ranges:

0-6 ohms with graduations beginning with .01.

6-600 ohms.

GENERATORS

The generator is a device for changing mechanical energy into electrical energy. Generators are built in many voltages and design to fit the special requirements of the application for which they are intended. Some generators are completely sealed to exclude moisture or dust. Others are ventilated by a suction fan usually combined with the drive pulley. A typical ventilated generator is illustrated in Figure 29. The air stream passing over the armature and field coils carries away the excess heat and allows a much higher output without the danger of burning out the armature or fields. Ventilated generators are used on most automotive and truck applications while non-ventilated generators are used on marine or tractor applications where dust or water are likely to cause damage.

Most passenger cars and light trucks use a hinge type mounting while large trucks and stationary engines may use flange, base or barrel type mounting. Special mountings are often designed to fit applications not adaptable to the standard hinge or flange types. The type of drive also varies for different applications.

The generator is the source of all electrical energy on a car. It supplies power for the ignition, lights, heater, radio and other accessories. The battery stores some of the generated energy in chemical form to be used when the generator is not running. The battery is not a source of electricity but only a storage reservoir. In starting for instance the battery supplies the energy but as soon as the engine starts the generator begins to replace the electricity taken from the battery. Thus the generator must be of sufficient capacity to supply all of the current used on the car.

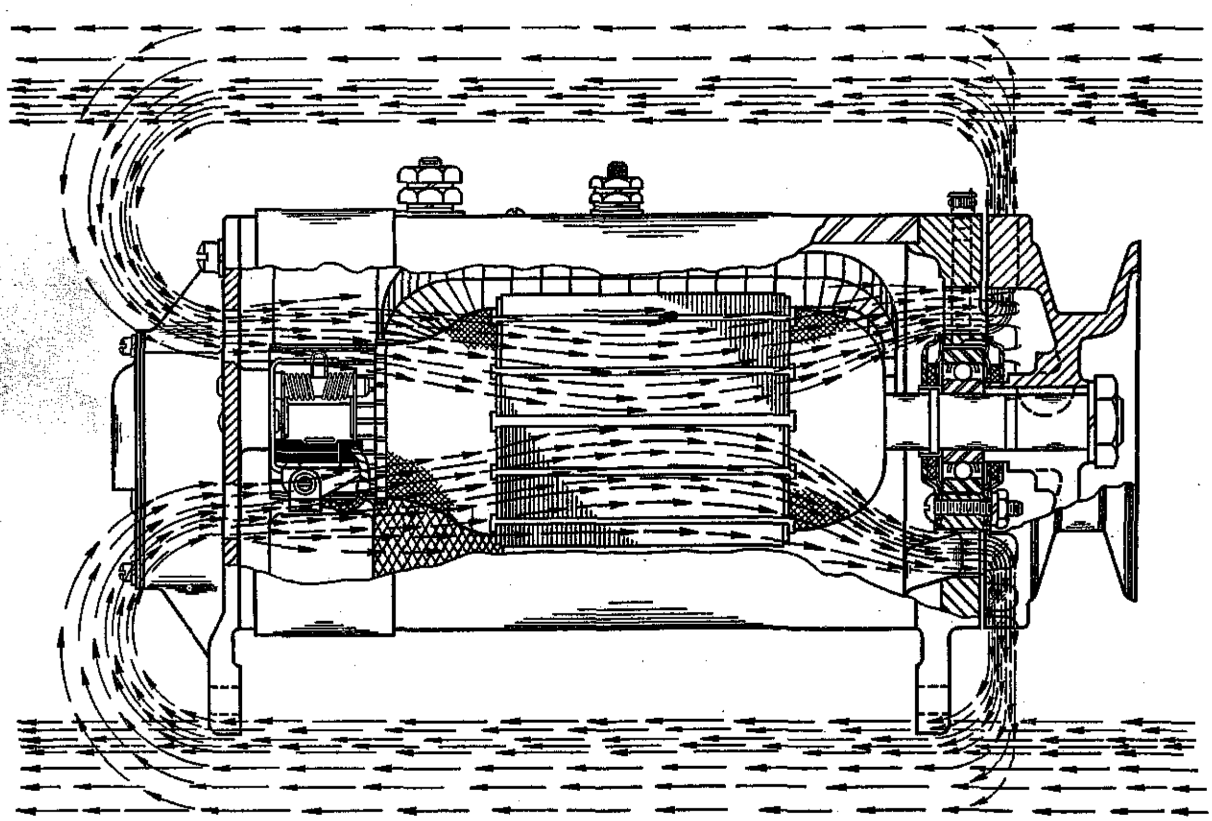


FIGURE 29

GENERATORS — Continued

Original equipment batteries are selected with sufficient capacity to crank the engine and supply enough electrical energy for the ignition system for starting the engine.

As the automobile has developed there has been an increase in the number of electrical uses. The lights have been increased in number and capacity, electric horns have become standard equipment, electric windshield wipers are being used and the newer cars are using solenoid controlled transmissions, electric window lifts, radios and many other electrical accessories. These developments have come gradually and with each new use of electricity it was necessary to increase the capacity of the generator.

There are two main types of generators. These are the third brush generator and the shunt generator.

THIRD BRUSH GENERATORS

The output of third brush generators is controlled by one of the following methods:

- Adjustable third brush.
- Adjustable third brush and two-charge regulator.
- Adjustable third brush and vibrating voltage regulator.
- Fixed third brush and vibrating voltage regulator.

1—Third Brush Control

With this type of control the output is varied by changing the voltage applied to the field coils by moving the third brush. Moving this brush in the direction of armature rotation increases the output while moving it against armature rotation decreases the output. Figure 30 shows a typical output curve. The internal wiring of a typical

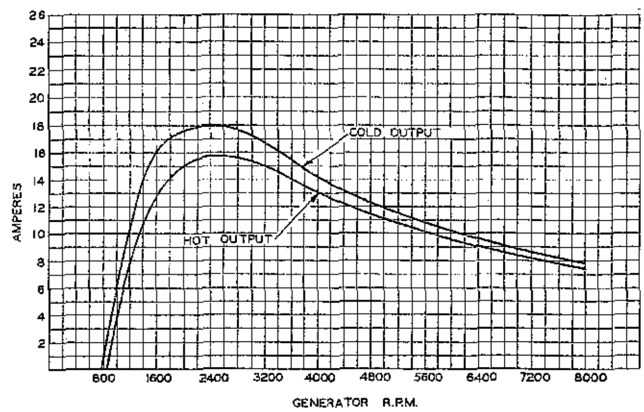


FIGURE 30

third brush generator and its connection to the circuit breaker are shown in Figure 31.

This type of unit is restricted to applications requiring low output generators.

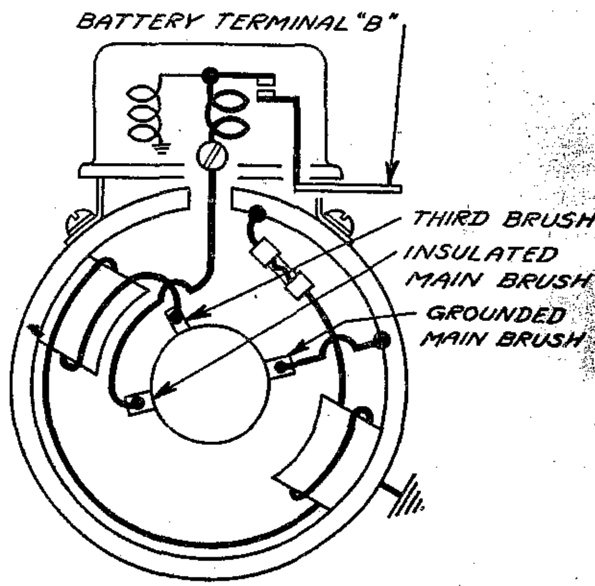


FIGURE 31

2—Third Brush Control with TC Regulator

The two charge regulator was developed for use with the third brush generator so that its output varied in accordance with the state of charge of the battery. The two charge regulator is designed to permit the generator to charge at its high rate until the voltage reaches a predetermined maximum at which time the output is reduced approximately 50%. The higher output is produced whenever the demands on the gener-

GENERATORS — Continued

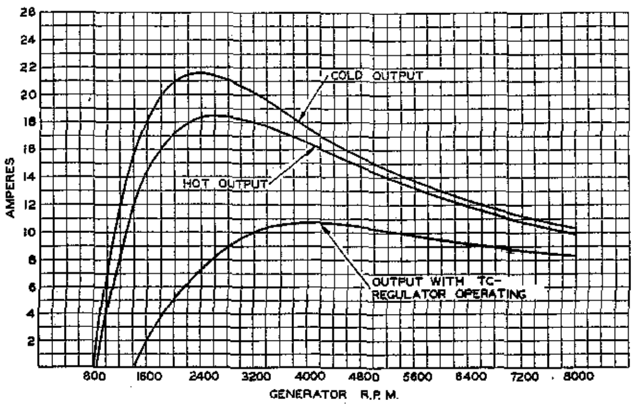


FIGURE 32

ator are large while the lower output is produced when the battery is full and the connected load is small. A typical charging curve of a third brush generator with a two charge regulator is shown in Figure 32 and the internal connections in Figure 33.

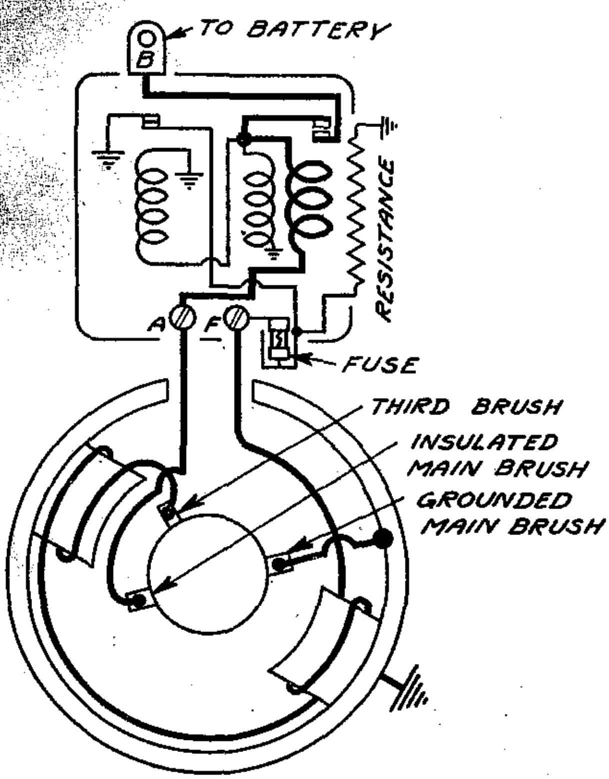


FIGURE 33

The two charge regulator allows a larger capacity generator to be used without overcharging the battery.

3—Third Brush Control with VR Regulator

When a vibrating type voltage regulator is used with a third brush generator the output conforms closely with the requirements of the battery and connected load. The regulator holds the generated voltage constant under wide variations of loading. Thus the charging rate varies to allow a high current when the battery is low or when a large load is being used. If the battery is fully charged and there is no accessory load the regulator holds the generator output to a low sustaining charge. When high resistance connections develop in the charging circuit the output is reduced. This prevents the increase in voltage obtained when high resistance occurs in a circuit without a vibrating type regulator or with a two charge regulator. This elimination of high voltage increases the life of lamp bulbs and of the ignition system.

When the vibrating type regulator is used with a third brush generator it is possible to use a much higher capacity generator without danger of overcharging the battery. The maximum current is still controlled by the third brush. A typical charging curve and wiring diagram of a third brush generator with vibrating voltage regulation are shown in Figures 34 and 35. The heavy

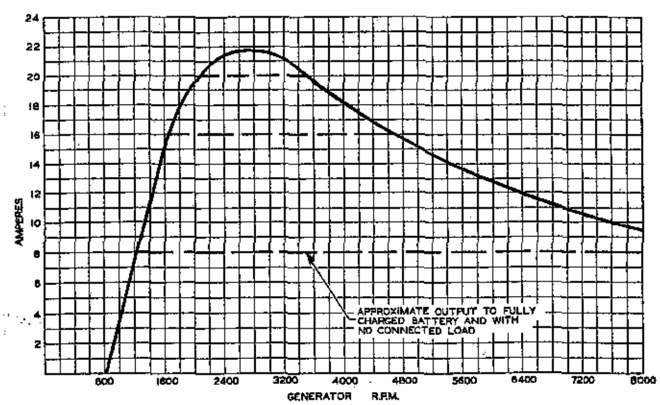


FIGURE 34

GENERATORS — Continued

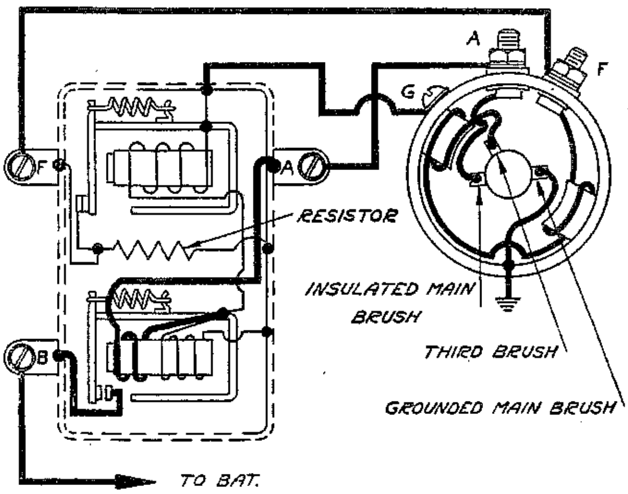


FIGURE 35

line indicates the maximum output and the dotted lines indicate the decrease in output as the battery becomes charged.

4—Fixed Third Brush with VR Regulator

The operation of this type is identically the same as the preceding type except that the position of the third brush is not adjustable.

SHUNT GENERATORS

With the development of high output generators it became desirable to eliminate the decrease in output at high speeds and also to lower the generator speed at which the maximum output is produced. This was done by using a shunt generator and eliminating the third brush control. With a shunt generator it is necessary to provide some method for limiting the maximum output of the generator to a safe value. The current limiting regulator was developed for this purpose. When a voltage and current limiting regulator is used in conjunction with a shunt generator a charging rate is obtained that is fully dependent on the requirements of the circuit. Such a curve is illustrated in Figure 36. Figure 37 shows the internal wiring of a shunt generator and a voltage and current limiting regulator.

MAINTENANCE PROCEDURE A periodic inspection should be made of the charging circuit. The interval between these checks will vary depending upon the type of service. Dirt, dust and high speed operation are factors which contribute to increased wear of the bearings, brushes, etc. Under normal conditions an inspection of the generator should be made each 5000 miles.

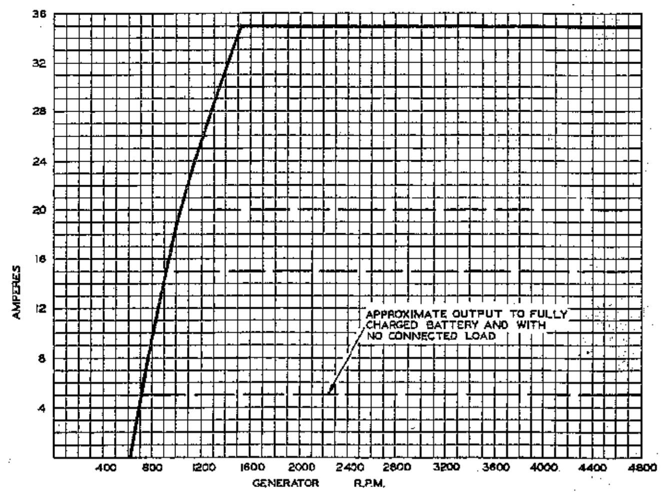


FIGURE 36

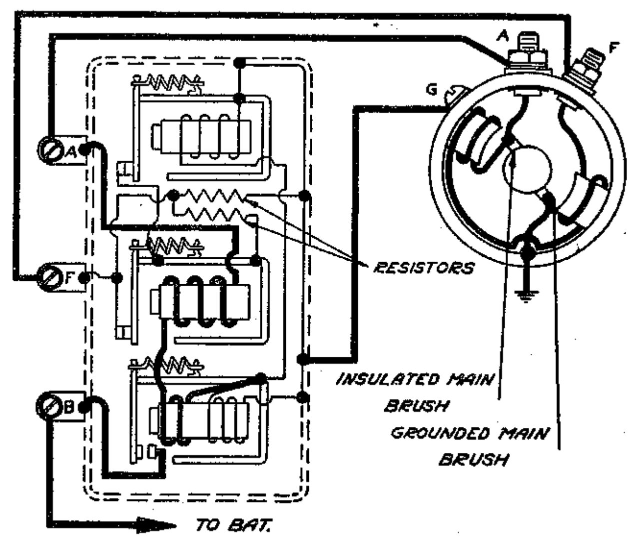


FIGURE 37

1. Wiring

A visual inspection should be made of all wiring to be sure that there are no broken wires and that all connections are clean and tight.

GENERATORS — Continued

2. *Commutator*.

If the commutator is dirty or discolored it can be cleaned by holding a piece of 00 sandpaper against it while running the armature slowly. Blow the sand out of the generator after cleaning the commutator. If the commutator is rough or worn the generator should be removed from the vehicle, the armature removed and the commutator turned down. See page 31 for instructions on this operation.

3. *Brushes*

The brushes should slide freely in their holders. If the brushes are oil soaked or if they are worn to less than one half of their original length they should be replaced. See page 32 for servicing instructions.

4. *Brush Spring Tension*

The brush spring tension should be checked. If the tension is excessive the brushes and commutator will wear very rapidly while if the tension is low arcing between the brushes and commutator and reduced output will result. See page 34 for test figures.

5. *Lubrication*

Add 5 to 10 drops of medium engine oil (A good grade of S.A.E. No. 20 oil) to the oilers. Grease cups should be filled with a high melting point grease and periodically turned down one turn.

GENERATOR OVERHAUL At periods of approximately 15,000 miles the charging circuit should be thoroughly checked and the generator removed from the vehicle and reconditioned.

1. *Wiring*

Be sure that all connections are clean and tight and that there are no broken wires. To check connect an ammeter between the battery terminal of the circuit breaker or regulator and the lead removed from this terminal. Run the engine at a speed equivalent to 20 M.P.H. Adjust the current to 10 amperes by turning on the lights. At this 10 ampere charging rate a voltage reading should be taken with a 10 volt voltmeter between the following points. See Figure 38.

a. BG to GG 0 volts

b. BG to RG 0 volts

c. RG to GG 0 volts

d. RA to GA .1 volts

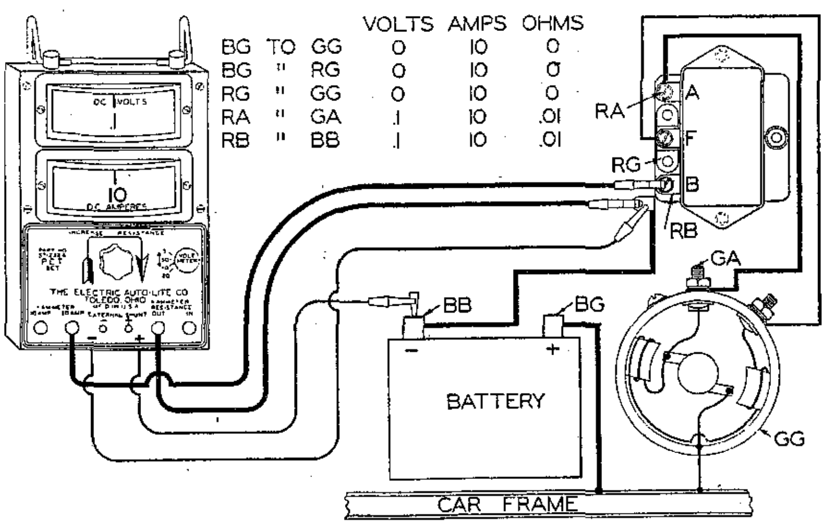


FIGURE 38

GENERATORS — Continued

e. RB to BB .1 volts

If readings higher than these are obtained the wiring should be checked for high resistance connections.

2. *Armature*

The armature should be visually inspected for mechanical defects.

If the commutator is rough or worn it should be turned down in a lathe. After turning the commutator the mica should be undercut to a depth of 1/32". When undercutting the mica the cut should be square and free from burrs. The maximum eccentricity of the commutator is not to exceed .0003 inches.

For testing armature circuits it is advisable to use a set of test probes such as shown in Figure 39.

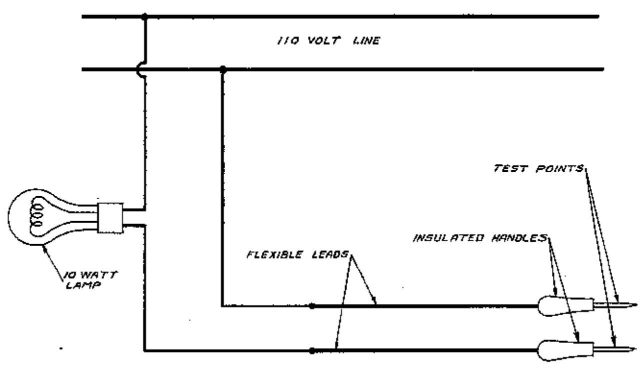


FIGURE 39

To test armatures for grounds connect one point to the core or shaft (not on bearing surfaces) and touch a commutator segment with the other probe. If the lamp lights the armature winding is grounded and the armature should be replaced.

To test for shorted armature coils a growler (Figure 40) is necessary. Place the armature on the growler and hold a thin steel strip on the armature core. The armature is then rotated slowly by hand and if a shorted coil is present

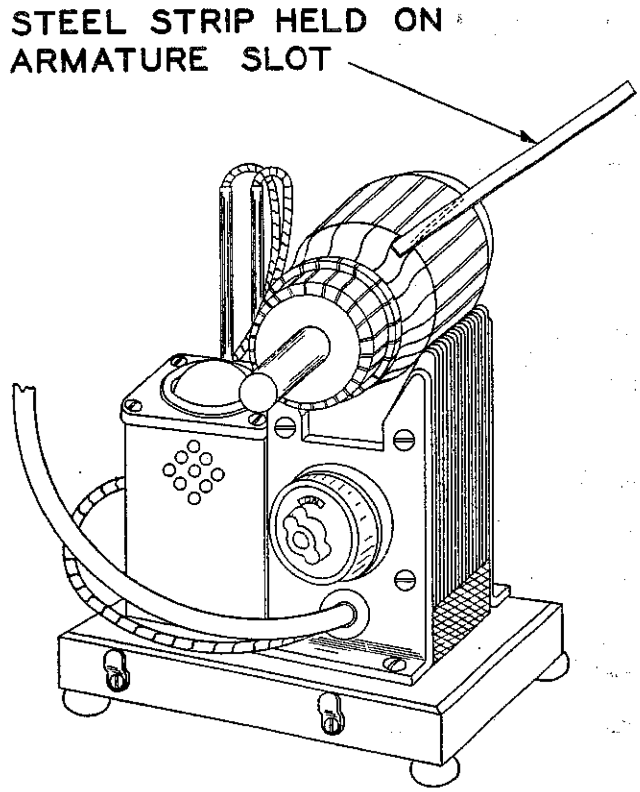


FIGURE 40

the steel strip will vibrate.

3. *Field Coils*

Using the test probes illustrated in Figure 39 check the field coils for both opens and grounds.

To test for open coils connect the probes to the two leads of each coil. If the lamp fails to light the coil is open and should be replaced.

To test for grounds place one probe on the generator frame and the other to the field coil terminals. If a ground is present the lamp will light and the coil should be replaced.

4. *Brush Holders*

With the test probes check the insulated brush holder to be sure it is not grounded. Touch the insulated brush holder with one probe and a convenient ground on the C.E. Plate with the other probe. If the lamp lights it indicates a grounded brush holder.

GENERATORS — Continued

Inspect the brush holders for distortion and improper alignment. The brushes should swing or slide freely and should be perfectly in line with the commutator segments.

5. *Brushes*

Brushes that have been subjected to oil or are worn to one-half or less of their original length should be replaced.

When replacing brushes it is necessary to seat them so that they have 100% surface contacting on the commutator. The brushes should be sanded to obtain this fit. This can be done by drawing a piece of 00 sandpaper between the commutator and brush and against the brush holder as illustrated in Figure 41. Do not sand

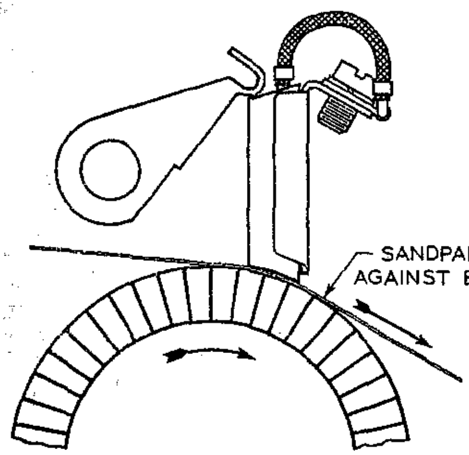


FIGURE 41

too much as it merely shortens brush life. After sanding the brushes blow the sand and carbon dust out of the generator. The generator should then be run under load long enough to secure a perfect brush fit. Generators are not to be tested for output until after the brushes are seated.

6. *Assembly of Generator*

When assembling absorbent bronze bearings always use the proper arbor as these arbors are designed to give the proper bearing fit.

When assembling bearings or end heads that are equipped with oil wicks always remove the wick and replace it only after the armature and end heads are assembled.

Absorbent bronze bearings and wicks should be soaked in oil before assembling and the ball bearings should be packed one half full with a heat resisting grease before assembly.

7. *Lubrication*

Generator armatures may be mounted in ball bearings or in oil absorbent bronze bearings. The drive end bearing is usually a ball bearing while the commutator end bearing may be either ball or absorbent bronze depending on the size and application of the generator.

Nearly all generators are provided with oilers at both ends. These oilers are usually of the following types:

a. Hinged top — These are located over the bearing and should be given 5 to 10 drops of medium engine oil every 5000 miles.

b. Swinging type—This type is used only on the commutator end cap cover and should be filled full of medium engine oil every 5000 miles.

c. Cup and wick oilers—This type is found under the bearing. The cup should be removed and filled with medium oil every 5000 miles.

d. Grease cups—These are usually located at the side of the end plates. The cups should be given one turn every 5000 miles. When refilling cups use a high melting point grease.

GENERATORS — Continued

e. Cup oilers—This type of oiler has a spring cover and is found at the side of the end plates. The cups should be filled with medium engine oil every 5000 miles.

When the generator is disassembled and cleaned the absorbent bronze bearings should be soaked in oil before assembling and the ball bearings should be packed one half full with a high melting point grease. Care must be taken not to over-lubricate any of the bearings as the surplus oil may deposit on the commutator or brushes allowing them to become oil soaked and seriously affect the operation of the generator.

8. *Generator Test*

After the generator is assembled and the brushes are properly fitted the generator should be bench tested under conditions of speed, voltage, amperes and temperature as near as possible the same as when in operation on the car before installing on the car. See pages 34 to 39 for complete test data.

All generators should be polarized with the car battery before running. This can be done by using a jumper from the starting switch battery terminal to the armature terminal of the generator.

GENERATOR TEST DATA

The following numerical list of Auto-Lite generators shows the rotation, type of control, test to which it is set and the brush spring tension.

Test specifications on the following generators are shown on page 39.

NOTE:—Where the suffix letter has been omitted the test data is the same as given for the straight number. In a few instances the test data is not the same and in such cases the units are listed separately.

ABBREVIATIONS USED IN THE FOLLOWING TABULATION

CW—Clockwise rotation at the drive end.

CCW—Counter clockwise rotation at the drive end

CB—Third brush control with circuit breaker

TC—Third brush and two charge regulator control

VR—Third brush and vibrating voltage regulator

CVR—Shunt type with vibrating current and voltage regulator

Unit	Rot. D.E.	Control	Test No.	Spring Tension Ounces
GAE-4020	CW	CB	GAE-0	20-26
GAE-4021	CCW	CB	GAE-0	20-26
GAE-4022	CW	CB	GAE-0	20-26
GAE-4023	CW	TC	GAE-0	20-26
GAE-4024	CCW	TC	GAE-0	20-26
GAE-4026	CCW	CB	GAE-0	20-26
GAE-4027	CW	CB	GAE-0	20-26
GAE-4029	CW	CB	GAE-0	20-26
GAE-4031	CW	CB	GAE-0	20-26
GAE-4037	CW	TC	GAE-0	20-26
GAE-4040	CW	TC	GAE-0	20-26
GAE-4041	CW	TC	GAE-0	20-26
GAE-4042	CW	TC	GAE-0	20-26
GAE-4043	CCW	TC	GAE-0	20-26
GAE-4044	CCW	CB	GAE-0	20-26
GAE-4045	CW	TC	GAE-0	20-26
GAE-4046	CCW	TC	GAE-0	20-26
GAE-4047	CW	TC	GAE-0	20-26
GAG-4133	CW	CB	GAG-0	22-27
GAG-4145	CW	TC	GAG-0	22-27
GAG-4146	CW	TC	GAG-0	22-27
GAG-4147	CW	CB	GAG-0	22-27
GAG-4148	CW	CB	GAG-0	22-27
GAG-4149	CW	TC	GAG-0	22-27
GAG-4150	CW	CB	GAG-0	22-27
GAG-4151	CCW	CB	GAG-0	22-27
GAL-4336	CW	CB	GAL-0	17-22
GAL-4340	CCW	CB	GAL-0	17-22
GAM-4504	CW	CB	GAM-0	18-22
GAM-4601	CW	CB	GAM-0	18-22
GAP-4133	CW	CB	GAP-0	22-27
GAP-4135	CW	CB	GAP-0	22-27
GAP-4140	CW	CB	GAP-0	22-27
GAP-4157	CW	CB	GAP-0	22-27
GAP-4158	CCW	CB	GAP-0	22-27
GAP-4159	CW	CB	GAP-0	22-27
GAP-4160	CCW	CB	GAP-0	22-27
GAR-4302	CW	CB	GAR-0	17-22
GAR-4316	CCW	CB	GAR-0	17-22
GAR-4502	CW	CB	GAR-0	18-22
GAR-4513	CW	CB	GAR-0	18-22
GAR-4515	CW	CB	GAR-0	18-22
GAR-4518	CCW	CB	GAR-0	18-22
GAR-4520	CCW	CB	GAR-0	18-22
GAR-4521	CW	CB	GAR-0	18-22
GAR-4522	CW	CB	GAR-0	18-22
GAR-4524	CW	CB	GAR-0	18-22
GAR-4525	CW	CB	GAR-0	18-22
GAR-4527	CCW	CB	GAR-0	17-22
GAR-4534	CW	CB	GAR-0	18-22
GAR-4535	CW	CB	GAR-0	18-22
GAR-4536	CCW	CB	GAR-0	18-22
GAR-4537	CW	CB	GAR-0	18-22
GAR-4540	CW	CB	GAR-0	18-22
GAR-4541	CW	CB	GAR-0	18-22
GAR-4542	CCW	CB	GAR-0	17-22
GAR-4543	CW	CB	GAR-0	18-22
GAR-4544	CCW	CB	GAR-0	17-22
GAR-4545	CW	CB	GAR-0	18-22
GAR-4546	CCW	CB	GAR-0	17-22
GAR-4547	CW	CB	GAR-0	18-22
GAR-4548	CCW	TC	GAR-0	17-22
GAR-4549	CW	CB	GAR-0	18-22
GAR-4550	CW	TC	GAR-0	18-22
GAR-4551	CCW	TC	GAR-0	18-22
GAR-4553	CCW	TC	GAR-0	18-22
GAR-4554	CW	CB	GAR-0	18-22
GAR-4555	CW	TC	GAR-0	18-22
GAR-4601	CW	CB	GAR-5	50-60
GAR-4603	CW	CB	GAR-5	50-60
GAR-4604	CW	CB	GAR-3	50-60
GAR-4605	CW	TC	GAR-4	50-60
GAR-4606	CW	TC	GAR-3	50-60
GAR-4607	CW	CB	GAR-3	50-60
GAR-4608	CW	TC	GAR-5	50-60
GAR-4609	CW	TC	GAR-4	50-60
GAR-4610	CW	TC	GAR-4	50-60
GAR-4611	CW	TC	GAR-5	50-60
GAR-4612	CW	TC	GAR-3	50-60

GENERATORS — Continued

Unit	Rot. D.E.	Control	Test No.	Spring Tension Ounces
GAR-4613-3	CW	TC	GAR-3	50-60
GAR-4613-4	CW	TC	GAR-4	50-60
GAR-4614-4	CW	TC	GAR-4	50-60
GAR-4614-5	CW	TC	GAR-5	50-60
GAR-4616	CW	TC	GAR-3	50-60
GAR-4617	CW	TC	GAR-3	50-60
GAR-4618	CW	CB	GAR-2	50-60
GAR-4619	CW	TC	GAR-3	50-60
GAR-4620	CW	TC	GAR-5	50-60
GAR-4621	CCW	TC	GAR-3	50-60
GAR-4622	CW	CB	GAR-3	50-60
GAR-4623	CW	TC	GAR-4	50-60
GAR-4624	CW	TC	GAR-5	50-60
GAR-4625	CW	TC	GAR-5	50-60
GAR-4626	CW	CB	GAR-3	50-60
GAR-4627	CW	TC	GAR-3	50-60
GAR-4630	CW	TC	GAR-5	50-60
GAR-4631	CW	TC	GAR-5	50-60
GAR-4632	CW	CB	GAR-3	50-60
GAR-4633	CW	CB	GAR-3	50-60
GAR-4634	CW	CB	GAR-2	50-60
GAR-4635	CW	TC	GAR-5	50-60
GAR-4701	CW	TC	GAR-6	18-22
GAR-4702	CW	CB	GAR-0	18-22
GAS-4102	CCW	CB	GAS-0	15-20
GAS-4102-1	CCW	CB	GAS-1	15-20
GAS-4102A	CCW	CB	GAS-1	15-20
GAS-4102B	CCW	CB	GAS-1	15-20
GAS-4102C	CCW	CB	GAS-0	15-20
GAS-4103	CW	CB	GAS-1	15-20
GAS-4104	CW	CB	GAS-0	15-20
GAS-4104-1	CW	CB	GAS-1	15-20
GAS-4104A	CW	CB	GAS-0	15-20
GAS-4104B	CW	CB	GAS-0	15-20
GAS-4106	CW	CB	GAS-0	15-20
GAS-4108	CCW	CB	GAS-0	15-20
GAS-4110	CW	CB	GAS-0	15-20
GAS-4111	CCW	CB	GAS-0	15-20
GAS-4114	CCW	CB	GAS-0	15-20
GAS-4119	CW	CB	GAS-0	15-20
GAS-4120	CW	CB	GAS-0	15-20
GAS-4120-1	CW	CB	GAS-1	15-20
GAS-4120A	CW	CB	GAS-0	15-20
GAS-4124	CCW	CB	GAS-1	15-20
GAS-4125	CW	CB	GAS-0	15-20
GAS-4125-1	CW	CB	GAS-1	15-20
GAS-4126	CCW	CB	GAS-0	15-20
GAS-4128	CW	CB	GAS-0	15-20
GAS-4129	CW	CB	GAS-0	15-20
GAS-4131	CW	CB	GAS-1	15-20
GAS-4132	CCW	CB	GAS-0	15-20
GAS-4136	CW	TC	GAS-1	15-20
GAS-4139	CW	CB	GAS-0	15-20
GAS-4140	CW	CB	GAS-0	15-20
GAS-4141	CW	CB	GAS-0	15-20
GAS-4144	CW	CB	GAS-0	15-20
GAS-4145	CW	TC	GAS-0	15-20
GAS-4148	CW	TC	GAS-1	15-20
GAS-4149	CCW	TC	GAS-1	15-20
GAS-4150	CCW	CB	GAS-1	15-20
GAS-4151	CW	CB	GAS-1	15-20
GAS-4152	CCW	CB	GAS-0	15-20
GAS-4157	CW	TC	GAS-0	15-20
GAS-4159	CW	TC	GAS-1	15-20
GAS-4160	CW	CB	GAS-0	15-20
GAS-4161	CW	CB	GAS-0	15-20
GAS-4162	CW	CB	GAS-0	15-20
GAS-4163	CW	TC	GAS-0	15-20
GAS-4164	CW	CB	GAS-0	15-20
GAS-4165	CW	TC	GAS-0	15-20
GAS-4166	CCW	CB	GAS-1	15-20
GBB-4304	CW	TC	GBB-0	22-27
GBE-4201	CW	CB	GBE-0	50-60
GBE-4202	CCW	CB	GBE-0	50-60
GBE-4203	CW	CB	GBE-0	50-60
GBE-4204	CCW	CB	GBE-0	50-60
GBE-4205	CW	CB	GBE-0	50-60
GBE-4206	CCW	CB	GBE-0	50-60
GBE-4207	CCW	CB	GBE-0	50-60
GBE-4208	CW	CB	GBE-0	50-60
GBE-4209	CCW	TC	GBE-0	50-60
GBE-4301	CW	CB	GBE-0	17-22
GBG-4601	CW	CVR	GBG-0	23-26
GBG-4602	CW	CVR	GBG-0	23-26
GBG-4603	CW	CVR	GBG-0	23-26
GBG-4604	CW	CVR	GBG-0	23-26
GBG-4606	CW	CVR	GBG-0	23-26
GBG-4607	CW	CVR	GBG-0	23-26
GBG-4608	CW	CVR	GBG-0	23-26
GBG-4609	CW	CVR	GBG-0	23-26
GBG-4610	CCW	CVR	GBG-0	23-26
GBG-4611	CW	CVR	GBG-0	23-26
GBJ-4601	CW	TC	GBJ-0	50-60
GBK-4601	CW	CB	GBK-2	18-22
GBK-4602	CW	TC	GBK-1	18-22
GBK-4603	CW	CB	GBK-0	18-22
GBK-4604	CW	CB	GBK-0	18-22
GBM-4601	CW	CB	GBM-0	50-60
GBM-4602	CW	CB	GBM-0	50-60
GBM-4603	CW	CB	GBM-1	50-60
GBM-4604	CW	CB	GBM-1	50-60
GBM-4606	CW	CB	GBM-1	50-60
GBM-4607	CW	CB	GBM-1	50-60
GBM-4608	CW	CB	GBM-0	50-60
GBM-4608C	CW	CB	GBM-1	50-60
GBM-4609	CW	CB	GBM-0	50-60
GBM-4610	CW	CB	GBM-5	50-60
GBM-4611	CW	CB	GBM-4	50-60
GBM-4612	CW	CB	GBM-0	50-60
GBM-4613	CW	CB	GBM-1	50-60
GBM-4616	CW	TC	GBM-1	50-60
GBM-4617	CW	CB	GBM-5	50-60
GBM-4619	CCW	CB	GBM-5	50-60
GBM-4620	CW	CB	GBM-1	50-60
GBM-4801	CCW	CB	GBM-5	37-44†
GBM-4802	CW	TC	GBM-5	37-44†
GBM-4803	CW	CB	GBM-1	37-44†
GBM-4804	CW	CB	GBM-5	37-44†
GBM-4805	CW	CB	GBM-5	37-44†

†Third brush spring tension should be 50 to 60 ounces.

GENERATORS — Continued

Unit	Rot. D.E.	Control	Test No.	Spring Tension Ounces
GBM-4806	CW	CB	GBM-4	37-44†
GBM-4807	CW	TC	GBM-1	37-44†
GBM-4808	CW	TC	GBM-6	37-44†
GBM-4809	CW	TC	GBM-5	37-44†
GBM-4810	CW	CB	GBM-1	37-44†
GBR-4501	CW	CB	GBR-3	18-22
GBR-4502	CCW	CB	GBR-3	18-22
GBR-4601	CW	TC	GBR-5	50-60
GBR-4602	CW	TC	GBR-4	50-60
GBR-4603	CW	TC	GBR-4	50-60
GBR-4604	CW	TC	GBR-5	50-60
GBR-4605	CW	TC	GBR-5	50-60
GBR-4607	CW	TC	GBR-5	50-60
GBR-4608	CW	TC	GBR-5	50-60
GBR-4609	CW	TC	GBR-5	50-60
GBR-4611	CW	TC	GBR-5	50-60
GBR-4612	CW	TC	GBR-5	50-60
GBS-4501	CCW	CB	GBS-1	18-22
GBS-4502	CW	CB	GBS-1	18-22
GBS-4602	CW	TC	GBS-0	50-60
GBS-4605	CW	TC	GBS-0	50-60
GBS-4606	CCW	TC	GBS-0	50-60
GBU-4201	CW	TC	GBU-0	50-60
GBU-4202	CW	TC	GBU-0	50-60
GBU-4203	CCW	TC	GBU-0	50-60
GBU-4204	CW	TC	GBU-0	50-60
GBU-4206	CW	TC	GBU-0	50-60
GBU-4208	CW	CB	GBU-0	50-60
GBU-4209	CW	TC	GBU-0	50-60
GBU-4210	CW	CB	GBU-0	50-60
GBU-4211	CCW	CB	GBU-0	50-60
GBU-4213	CW	TC	GBU-0	50-60
GBU-4214	CW	TC	GBU-0	50-60
GBU-4216	CW	TC	GBU-0	50-60
GBU-4217	CCW	CB	GBU-0	50-60
GBW-4602	CW	CVR	GBW-0	53 Max.
GBW-4802	CW	CVR	GBW-0	53 Max.
GBW-4803	CW	CVR	GBW-0	53 Max.
GBW-4804	CW	CVR	GBW-0	53 Max.
GBW-4805	CW	CVR	GBW-0	53 Max.
GBW-4807	CW	CVR	GBW-1	53 Max.
GBW-4808	CW	CVR	GBW-1	53 Max.
GBX-4601	CW	TC	GBX-5	41-52
GBX-4602	CW	TC	GBX-5	41-52
GBY-4601	CW	TC	GBY-5	41-52
GBY-4801	CW	TC	GBY-5	64-68
GBY-4802	CW	TC	GBY-5	64-68
GCB-4601	CW	CVR	GCB-0	64-68
GCB-4802	CW	CVR	GCB-0	64-68
GCB-4803	CW	CVR	GCB-0	64-68
GCB-4804	CW	CVR	GCB-0	64-68
GCB-4805	CW	CVR	GCB-0	64-68
GCB-4806	CW	CVR	GCB-0	64-68
GCB-4808	CW	CVR	GCB-0	64-68
GCB-4809	CW	CVR	GCB-0	64-68
GCB-4810	CW	CVR	GCB-0	64-68
GCB-4811	CCW	CVR	GCB-0	64-68
GCB-4814	CW	CVR	GCB-0	64-68

Unit	Rot. D.E.	Control	Test No.	Spring Tension Ounces
GCB-4815	CW	CVR	GCB-0	64-68
GCB-4816	CW	CVR	GCB-0	64-68
GCB-4817	CW	CVR	GCB-0	64-68
GCB-4818	CW	CVR	GCB-0	64-68
GCB-4820	CW	CVR	GCB-0	64-68
GCB-4821	CW	CVR	GCB-0	64-68
GCD-4801	CW	CVR	GCD-0	55-65
GCD-4803	CW	CVR	GCD-0	55-65
GCD-4804	CW	CVR	GCD-0	55-65
GCD-4805	CW	CVR	GCD-0	55-65
GCD-4806	CCW	CVR	GCD-0	55-65
GCD-4807	CW	CVR	GCD-0	55-65
GCE-4803	CW	CVR	GCE-0	64-68
GCE-4804	CW	CVR	GCE-0	64-68
GCE-4806	CW	CVR	GCE-0	64-68
GCE-4807	CW	CVR	GCE-0	64-68
GCE-4808	CW	CVR	GCE-0	64-68
GCE-4809	CW	CVR	GCE-0	64-68
GCE-4810	CW	CVR	GCE-0	64-68
GCE-4812	CW	CVR	GCE-0	64-68
GCE-4813	CW	CVR	GCE-0	64-68
GCE-4814	CW	CVR	GCE-0	64-68
GCE-4815	CW	CVR	GCE-0	64-68
GCE-4816	CW	CVR	GCE-0	64-68
GCE-4817	CW	CVR	GCE-0	64-68
GCE-4822	CW	CVR	GCE-0	64-68
GCG-4601	CCW	No	GCG-0	24-36
GCH-4601	CW	CVR	GCH-0	23-26
GCH-4602	CW	CVR	GCH-0	23-26
GCH-4603	CW	CVR	GCH-0	23-26
GCH-4604	CW	CVR	GCH-0	23-26
GCH-4606	CW	CVR	GCH-0	23-26
GCH-4607	CW	CVR	GCH-1	23-26
GCH-4608	CW	CVR	GCH-1	23-26
GCH-4609	CW	CVR	GCH-0	23-26
GCJ-4801	CW	VR	GCJ-0	53 Max.
GCJ-4802	CW	VR	GCJ-0	53 Max.
GCJ-4803	CW	VR	GCJ-0	53 Max.
GCJ-4804	CW	CB	GCJ-1	53 Max.
GCJ-4805	CW	VR	GCJ-0	53 Max.
GCJ-4807	CW	VR	GCJ-2	53 Max.
GCJ-4808	CW	VR	GCJ-0	53 Max.
GCJ-4810	CW	VR	GCJ-2	53 Max.
GCJ-4811	CW	VR	GCJ-0	53 Max.
GCJ-4812	CCW	CB	GCJ-3	53 Max.
GCJ-4813	CCW	CB	GCJ-3	53 Max.
GCJ-4814	CW	CB	GCJ-3	53 Max.
GCJ-4815	CW	CB	GCJ-3	53 Max.
GCJ-4816	CCW	CB	GCJ-3	53 Max.
GCK-4801	CW	CVR	GCK-0	53 Max.
GCK-4802	CW	CVR	GCK-0	53 Max.
GCK-4804	CCW	CVR	GCK-1	53 Max.
GCK-4805	CW	CVR	GCK-0	53 Max.
GCK-4806	CW	CVR	GCK-1	53 Max.
GCK-4807	CCW	CVR	GCK-1	53 Max.
GCM-4802	CW	TC	GCM-4	53 Max.
GCM-4803	CW	CB	GCM-4	53 Max.
GCM-4804	CW	TC	GCM-4	53 Max.

†Third brush spring tension should be 50 to 60 ounces.

GENERATORS — Continued

Unit	Rot. D.E.	Control	Test No.	Spring Tension Ounces
GCM-4805	CCW	TC	GCM-4	53 Max.
GCM-4806	CW	CB	GCM-4	53 Max.
GCM-4807	CW	CB	GCM-4	53 Max.
GCM-4808	CW	CB	GCM-4	53 Max.
GCM-4809	CW	CB	GCM-4	53 Max.
GCM-4810	CW	TC	GCM-4	53 Max.
GCM-4811	CW	CB	GCM-4	53 Max.
GCM-4812	CW	CB	GCM-0	†53 Max.
GCM-4814	CCW	CB	GCM-0	†53 Max.
GCM-4815	CW	TC	GCM-4	53 Max.
GCM-4816	CW	TC	GCM-4	53 Max.
GCM-4818	CW	CB	GCM-0	†53 Max.
GCM-4820	CCW	CB	GCM-0	†53 Max.
GCM-4821	CW	CB	GCM-0	†53 Max.
GCM-4822	CW	TC	GCM-4	53 Max.
GCM-4824	CW	CB	GCM-4	53 Max.
GCM-4825	CW	CB	GCM-4	53 Max.
GCM-4827	CW	TC	GCM-0	†53 Max.
GCO-4801	CW	CVR	GCO-0	53 Max.
GCO-4802	CW	CVR	GCO-0	53 Max.
GCO-4803	CW	CVR	GCO-0	53 Max.
GCO-4804	CW	CVR	GCO-0	53 Max.
GCO-4806	CW	CVR	GCO-0	53 Max.
GCO-4807	CW	CVR	GCO-0	53 Max.
GCO-4808	CW	CVR	GCO-0	53 Max.
GCP-4801	CW	CVR	GCP-0	53 Max.
GCP-4802	CCW	CVR	GCP-0	53 Max.
GCR-4801	CW	CVR	GCR-0	53 Max.
GCR-4802	CW	CVR	GCR-0	53 Max.
GCR-4803	CW	CVR	GCR-0	53 Max.
GCR-4804	CW	CVR	GCR-0	53 Max.
GCS-4802	CW	TC	GCS-5	53 Max.
GCS-4803	CW	TC	GCS-5	53 Max.
GCS-4804	CW	TC	GCS-5	53 Max.
GCS-4805	CW	TC	GCS-5	53 Max.
GCS-4806	CW	TC	GCS-5	53 Max.
GCS-4807	CCW	CB	GCS-1	53 Max.
GCS-4808	CW	TC	GCS-5	53 Max.
GCS-4809	CW	TC	GCS-5	53 Max.
GCS-4810	CW	TC	GCS-5	53 Max.
GCS-4811	CW	TC	GCS-5	53 Max.
GCS-4812	CW	TC	GCS-5	53 Max.
GCS-4813	CW	TC	GCS-5	53 Max.
GCS-4814	CW	TC	GCS-5	53 Max.
GCS-4815	CW	TC	GCS-5	53 Max.
GCT-4801	CW	CB	GCT-1	53 Max.
GCT-4802	CW	VR	GCT-0	53 Max.
GCT-4803	CW	CB	GCT-1	53 Max.
GCT-4804	CW	VR	GCT-0	53 Max.
GCT-4805	CW	VR	GCT-0	53 Max.
GCT-4806	CW	VR	GCT-0	53 Max.
GCT-4807	CW	VR	GCT-0	53 Max.
GCT-4808	CW	VR	GCT-0	53 Max.
GCT-4810	CW	CB	GCT-1	53 Max.
GCT-4811	CW	CB	GCT-1	53 Max.
GCT-4812	CW	VR	GCT-1	53 Max.
GCW-4802	CCW	CVR	GCW-0	64-68
GCW-4804	CW	CVR	GCW-0	64-68

Unit	Rot. D.E.	Control	Test No.	Spring Tension Ounces
GCW-4805	CW	CVR	GCW-0	64-68
GCW-4806	CCW	CVR	GCW-0	64-68
GCX-4501	CW	CB	GCX-0	7-10
GCX-4502	CW	CB	GCX-0	7-10
GCX-4503	CW	CB	GCX-0	7-10
GCY-4601	CW	CVR	GCY-0	23-26
GCY-4603	CCW	CVR	GCY-1	23-26
GCY-4604	CCW	CVR	GCY-1	23-26
GCZ-4803	CCW	CB	GCZ-0	53 Max.
GCZ-4805	CCW	CB	GCZ-0	53 Max.
GCZ-4806	CW	CB	GCZ-0	53 Max.
GCZ-4807	CW	CB	GCZ-0	53 Max.
GDA-4801	CW	CVR	GDA-0	53 Max.
GDA-4802	CW	CVR	GDA-0	53 Max.
GDA-4803	CW	CVR	GDA-0	53 Max.
GDA-4804	CW	CVR	GDA-0	53 Max.
GDA-4805	CW	CVR	GDA-0	53 Max.
GDA-4806	CW	CVR	GDA-0	53 Max.
GDA-4807	CCW	CVR	GDA-0	53 Max.
GDA-4808	CW	CVR	GDA-0	53 Max.
GDA-4809	CW	CVR	GDA-1	53 Max.
GDA-4810	CW	CVR	GDA-1	53 Max.
GDB-4802	CCW	CB	GDB-2	†53 Max.
GDB-4803	CW	CB	GDB-2	†53 Max.
GDB-4804	CW	TC	GDB-0	†53 Max.
GDB-4805	CCW	TC	GDB-0	†53 Max.
GDB-4810	CCW	TC	GDB-0	†53 Max.
GDB-4812	CCW	TC	GDB-0	†53 Max.
GDB-4813	CCW	TC	GDB-2	†53 Max.
GDB-4814	CW	TC	GDB-0	†53 Max.
GDC-4601	CCW	No	GDC-0	50-60
GDE-4101	CW	TC	GDE-0	15-20
GDE-4102	CCW	TC	GDE-0	15-20
GDE-4103	CCW	TC	GDE-0	15-20
GDE-4104	CCW	TC	GDE-0	15-20
GDE-4105	CCW	TC	GDE-0	15-20
GDE-4106	CCW	TC	GDE-0	15-20
GDF-4801	CW	VR	GDF-0	53 Max.
GDF-4802	CW	VR	GDF-0	53 Max.
GDF-4803	CW	CB	GDF-1	53 Max.
GDF-4804	CW	VR	GDF-0	53 Max.
GDF-4805	CCW	CB	GDF-2	53 Max.
GDF-4806	CW	CB	GDF-2	53 Max.
GDF-4807	CW	CB	GDF-2	53 Max.
GDF-4808	CCW	CB	GDF-2	53 Max.
GDF-4812	CW	VR	GDF-0	53 Max.
GDF-4813	CW	CB	GDF-2	53 Max.
GDF-4814	CCW	CB	GDF-2	53 Max.
GDF-4815	CCW	VR	GDF-0	53 Max.
GDG-4501	CW	No	GDG-0	7-10
GDJ-4801	CCW	CVR	GDJ-0	71-76
GDJ-4802	CW	CVR	GDJ-0	71-76
GDJ-4803	CW	CVR	GDJ-0	71-76
GDJ-4804	CW	CVR	GDJ-0	71-76
GDJ-4805	CW	CVR	GDJ-0	71-76
GDJ-4806	CW	CVR	GDJ-0	71-76

†Third brush spring tension should be 50 to 60 ounces.

GENERATORS — Continued

Unit	Rot. D.E.	Control	Test No.	Spring Tension Ounces
GDM-4803	CW	CVR	GDM-1	55-65
GDM-4804	CW	CVR	GDM-1	55-65
GDM-4806	CCW	CVR	GDM-1	55-65
GDO-4601	CW	CVR	GDO-1	23-26
GDP-4801	CW	CVR	GDP-0	53 Max.
GDP-4802	CW	CVR	GDP-0	53 Max.
GDP-4803	CW	CVR	GDP-0	53 Max.
GDP-4809	CW	CVR	GDP-0	53 Max.
GDS-4801	CW	VR	GDS-0	53 Max.
GDS-4802	CW	VR	GDS-0	53 Max.
GDS-4803	CW	CB	GDS-1	53 Max.
GDT-4801	CW	CVR	GDT-0	55-65
GDT-4802	CW	CVR	GDT-0	55-65
GDT-4803	CW	CVR	GDT-0	55-65
GDU-4501	CW	CB	GDU-0	7-10
GDW-4601	CW	CVR	GDW-0	23-26
GDW-4604	CW	CVR	GDW-0	23-26
GDY-4104	CCW	TC	GDY-0	15-20
GDY-4106	CW	TC	GDY-0	15-20
GDZ-4801	CW	CVR	GDZ-0	53 Max.
GDZ-4802	CW	CVR	GDZ-0	53 Max.
GDZ-4803	CW	CVR	GDZ-0	53 Max.
GDZ-4804	CW	CVR	GDZ-0	53 Max.
GDZ-4805	CW	CVR	GDZ-0	53 Max.
GDZ-4806	CW	CVR	GDZ-0	53 Max.
GDZ-4807	CCW	CVR	GDZ-0	53 Max.
GDZ-4808	CCW	CVR	GDZ-0	53 Max.
GEA-4801	CW	CVR	GEA-0	53 Max.
GEA-4802	CW	CVR	GEA-1	53 Max.
GEA-4803	CW	CVR	GEA-0	53 Max.
GEA-4804	CW	CVR	GEA-0	53 Max.
GEB-4801	CW	CVR	GEB-0	64-68
GEB-4802	CW	CVR	GEB-0	64-68
GEB-4802C	CW	CVR	GEB-2	64-68
GEB-4803	CW	CVR	GEB-0	64-68
GEB-4804	CW	CVR	GEB-0	64-68
GEB-4805	CW	CVR	GEB-0	64-68
GEB-4806	CW	CVR	GEB-0	64-68
GEB-4807	CW	CVR	GEB-0	64-68
GEB-4808	CW	CVR	GEB-0	64-68
GEB-4809	CW	CVR	GEB-0	64-68
GEB-4810	CW	CVR	GEB-0	64-68
GEB-4811	CW	CVR	GEB-0	64-68
GEB-4812	CW	CVR	GEB-0	64-68
GEB-4813	CW	CVR	GEB-0	64-68
GEB-4814	CW	CVR	GEB-0	64-68
GEB-4815	CW	CVR	GEB-0	64-68
GEB-4816	CW	CVR	GEB-0	64-68
GEB-4817	CW	CVR	GEB-0	64-68
GEB-4818	CCW	CVR	GEB-0	64-68
GEB-4819	CCW	CVR	GEB-0	64-68
GEB-4820	CW	CVR	GEB-1	64-68
GEB-4821	CW	CVR	GEB-0	64-68
GEB-4822	CW	CVR	GEB-0	64-68
GEB-4823	CCW	CVR	GEB-0	64-68
GEB-4824	CW	CVR	GEB-1	64-68
GEB-4825	CW	CVR	GEB-0	64-68
GEB-4826	CW	CVR	GEB-3	64-68
GEB-4827	CW	CVR	GEB-0	64-68
GEB-4828	CW	CVR	GEB-0	64-68
GEB-4829	CW	CVR	GEB-0	64-68
GEC-4801	CW	VR	GEC-0	53 Max.
GED-4501	CW	CB	GED-0	7-10
GEE-4501	CW	CB	GEE-0	7-10
GEE-4502	CW	CB	GEE-0	7-10
GEF-4801	CW	CVR	GEF-0	53 Max.
GEF-4802	CCW	CVR	GEF-0	53 Max.
GEG-4801	CW	CVR	GEG-0	64-68
GEG-4802	CW	CVR	GEG-0	64-68
GEG-4803	CW	CVR	GEG-0	64-68
GEG-4805	CW	CVR	GEG-0	64-68
GEG-4806	CW	CVR	GEG-0	64-68
GEG-4807	CW	CVR	GEG-0	64-68
GEG-4809	CW	CVR	GEG-0	64-68
GEG-4810	CW	CVR	GEG-0	64-68
GEG-4811	CW	CVR	GEG-0	64-68
GEG-4812	CW	CVR	GEG-0	64-68
GEG-4813	CW	CVR	GEG-0	64-68
GEG-4814	CCW	CVR	GEG-0	64-68
GEG-4815	CCW	CVR	GEG-1	64-68
GEG-4816	CCW	CVR	GEG-1	64-68
GEG-4817	CW	CVR	GEG-1	64-68
GEG-4818	CW	CVR	GEG-0	64-68
GEG-4819	CCW	CVR	GEG-0	64-68
GEG-4820	CCW	CVR	GEG-1	64-68
GEG-4821	CW	CVR	GEG-0	64-68
GEG-4822	CW	CVR	GEG-0	64-68
GEH-4802	CW	CVR	GEH-0	64-68
GEH-4803	CCW	CVR	GEH-1	64-68
GEH-4804	CW	CVR	GEH-1	64-68
GEH-4805	CW	CVR	GEH-0	64-68
GEH-4806	CW	CVR	GEH-0	64-68
GEJ-4801	CW	CVR	GEJ-0	53 Max.
GEK-4801	CCW	CB	GEK-0	23-26
GEO-4801	CCW	CB	GEO-3	53 Max.
GEO-4802	CW	CB	GEO-3	53 Max.
GEO-4803	CW	TC	GEO-3	53 Max.
GEO-4804	CCW	CB	GEO-3	53 Max.
GEO-4805	CW	CB	GEO-3	53 Max.
GEO-4806	CCW	CB	GEO-3	53 Max.
GEO-4807	CCW	CB	GEO-3	53 Max.
GEO-4808	CCW	TC	GEO-3	53 Max.
GEO-4809	CW	CB	GEO-3	53 Max.
GEP-4801	CW	‡	GEP-0	53 Max.
GER-4801	CW	VR	GER-0	53 Max.
GES-4801	CW	CVR	GES-0	53 Max.
GET-4501	CW	CB	GET-0	7-10
GEW-4801	CCW	CVR	GEW-0	64-68
GEW-4802	CW	CVR	GEW-0	64-68
GEW-4803	CW	CVR	GEW-0	64-68

‡CB or TC

GENERATORS — Continued

Unit	Rot. D.E.	Control	Test No.	Spring Tension Ounces
GEW-4804	CW	CVR	GEW-0	64-68
GEW-4805	CCW	CVR	GEW-0	64-68
GEX-4801	CCW	CVR	GEX-0	64-68
GFA-4801	CW	TC	GFA-2	53 Max.
GFA-4802	CCW	CB	GFA-2	53 Max.
GFA-4803	CW	CB	GFA-2	53 Max.
GFA-4804	CW	CB	GFA-2	53 Max.
GFA-4805	CCW	CB	GFA-2	53 Max.

Test No.	Field Current at 6.0 Volts (Amperes)	Cold Output Volts	Cold Output Amps.	Max. R.P.M.
GAE-0	1.9-2.1*	15.0	10.5-12.5	....
GAG-0	4.08-4.52	8.0	15.0-17.0	....
GAL-0	3.51-3.89	8.0	16.0-18.0	....
GAM-0	3.89-4.31	8.0	15.5-17.5	....
GAP-0	2.85-3.15	8.0	15.0-17.0	....
GAR-0	3.51-3.89	8.0	15.0-17.0	....
GAR-2	3.70-4.10	8.0	17.0-19.0	....
GAR-3	3.70-4.10	8.0	19.0-21.0	....
GAR-4	3.75-4.15	8.0	22.4-24.4	....
GAR-5	3.51-3.89	8.0	20.4-22.4	....
GAR-6	3.51-3.89	8.0	20.5-22.5	....
GAS-0	3.80-4.20	8.0	13.3-15.3	....
GAS-1	3.80-4.18	8.0	6.6-7.6	....
GBB-0	3.32-3.68*	15.0	16.0-18.0	....
GBE-0	2.75-3.05*	15.0	14.0-16.0	....
GBG-0	1.38-1.52*	15.0	40.0	1065
GBJ-0	4.18-4.62	8.0	24.0-26.0	....
GBK-0	3.94-4.36	8.0	19.0-21.0	....
GBK-1	3.94-4.36	8.0	21.0-23.0	....
GBK-2	4.08-4.52	8.0	15.5-17.5	....
GBM-0	3.80-4.20	8.0	19.0-21.0	....
GBM-1	3.80-4.20	8.0	17.0-19.0	....
GBM-4	3.80-4.20	8.0	10.0-12.0	....
GBM-5	3.80-4.20	8.0	14.0-16.0	....
GBM-6	3.80-4.20	8.0	8.0-10.0	....
GBR-3	4.13-4.57	8.0	16.0-18.0	....
GBR-4	4.13-4.57	8.0	25.0-27.0	....
GBR-5	4.18-4.62	8.0	21.0-23.0	....
GBS-0	3.23-3.57*	15.0	10.0-12.0	....
GBS-1	3.23-3.57*	15.0	9.6-10.6	....
GBU-0	3.51-3.89	8.0	9.7-11.7	....
GBW-0	1.66-1.84	8.0	22.0	1800
GBW-1	1.66-1.84	8.0	14.0	1380
GBX-5	2.85-3.15	8.0	28.8-30.8	....
GBY-5	2.66-2.94	8.0	20.0-22.0	....
GCB-0	1.50-1.70	8.0	25.0	1025
GCD-0	1.37-1.52*	15.0	20.0	1110
GCE-0	1.66-1.84	8.0	30.0	1500
GCG-0†	2.3-2.4	8.0	30.0	4010
GCH-0	1.17-1.29	8.0	40.0	975
GCH-1	1.17-1.29	8.0	50.0	1025
GCJ-0	1.9-2.1	8.0	24.0-26.0	....
GCJ-1	1.9-2.1	8.0	17.0-19.0	....
GCJ-2	1.9-2.1	8.0	29.0-32.0	....
GCJ-3	1.9-2.1	8.0	17.0-19.0	....
GCK-0	1.45-1.65*	15.0	12.0	1500
GCK-1	1.45-1.65*	15.0	8.0	1275
GCM-0	3.51-3.89	8.0	15.0-17.0	....
GCM-4	3.50-3.89	8.0	21.0-23.0	....
GCO-0	1.47-1.63	8.0	28.0	1850
GCP-0	1.70-1.90	8.0	12.0	1275
GCR-0	1.47-1.63*	15.0	15.0	1565
GCS-1	3.56-3.94	8.0	13.0-15.0	....
GCS-5	3.56-3.94	8.0	19.0-21.0	....
GCT-0	1.40-1.60*	15.0	12.0-13.0	....
GCT-1	1.40-1.60*	15.0	8.0-9.0	....
GCW-0	1.35-1.50*	15.0	17.0	1170
GCX-0	3.9-4.4	7.0	2.0	410
GCY-0	1.19-1.32*	15.0	33.0	1100
GCY-1	1.19-1.32*	15.0	20.0	950
GCZ-0	1.90-2.10	8.0	20.0-22.0	....
GDA-0	1.66-1.84	8.0	28.0	2025
GDA-1	1.66-1.84	8.0	25.0	1880
GDB-2	3.22-3.58*	15.0	9.0-11.0	
GDC-0§	1.3-1.6*	....		
GDE-0	3.80-4.20	8.0	17.0-19.0	
GDF-0	1.90-2.10	8.0	29.0-32.0	
GDF-1	1.90-2.10	8.0	17.0-19.0	
GDF-2	1.90-2.10	8.0	19.0-21.0	
GDG-0	3.90-4.40	7.0	2.0	410
GDJ-0	1.48-1.64*	15.0	55.0	1080
GDM-1	1.41-1.56*	15.0	30.0	1275
GDO-1	1.10-1.30	8.0	30.0	840
GDP-0	1.45-1.65*	15.0	15.0	1650
GDS-0	1.65-1.82	8.0	32.0-34.0	
GDS-1	1.65-1.82	8.0	19.0-21.0	
GDT-0	1.58-1.79	8.0	40.0	1350
GDU-0	3.5-3.9	8.0	17.0-19.0	
GDW-0	.87- .97‡	30.0	10.0	925
GDY-0	2.24-2.48*	15.0	6.0-7.0	
GDZ-0	1.60-1.78	8.0	30.0-36.7	
GEA-0	1.57-1.75	8.0	35.0	1500
GEA-1	1.57-1.75	8.0	35.0	1700
GEB-0	1.60-1.78	8.0	32.0	1165
GEB-1	1.60-1.78	8.0	16.0	885
GEB-2	1.60-1.78	8.0	35.0	1200
GEB-3	1.60-1.78	8.0	25.0	1100
GEC-0	1.60-1.78	8.0	39.0-43.0	....
GED-0	1.87-2.06*	15.0	8.0-10.0	
GEE-0	2.25-2.48	8.0	13.0-15.0	....
GEF-0	1.40-1.58*	15.0	18.0	1650
GEG-0	1.60-1.78	8.0	40.0	1465
GEG-1	1.60-1.78	8.0	20.0	1200
GEH-0	1.38-1.53*	15.0	17.0	1125
GEH-1	1.38-1.53*	15.0	10.0	1015
GEJ-0	1.65-1.82	8.0	16.0	1250
GEK-0	2.65-2.92*	15.0	21.0-23.0	....
GEO-3	1.65-1.82	8.0	18.0-20.0	....
GEP-0	1.65-1.82	8.0	19.0-21.0	....
GER-0	1.60-1.78	8.0	39.0-43.0	....
GES-0	1.57-1.75	8.0	35.0	1500
GET-0	2.06-2.29*	14.2	11.0-13.0	....
GEW-0	1.60-1.78	8.0	25.0	960
GFA-2	1.65-1.82	8.0	15.0-17.0	....

†Stall torque 4.3 Ft. Lbs., at 5.0 Volts and 165 Max. Amps.
§Stall torque 5.0 Ft. Lbs. at 115 Max. Amps. and 10.0 Volts.
*Field Current at 13.0 Volts.
‡Field Current at 25.0 Volts.

RELAYS AND REGULATORS

CB, CBA and RA CIRCUIT BREAKERS

DESCRIPTION AND FUNCTION The function of a circuit breaker in automotive electrical equipment is to automatically open and close the circuit between the generator and the storage battery.

It consists of an electromagnet and a set of contacts. The electromagnet has two windings; one, the shunt coil connected across the generator like a voltmeter, and the other a series coil connected in series with the generator output like an ammeter. (See Figure 42)

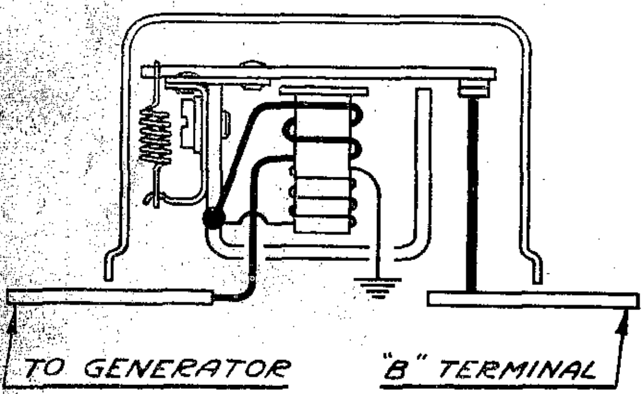


FIGURE 42

When the generator is charging the battery the current is flowing through both windings in the same direction. When the current flows from the battery to the generator, the current is flowing through the shunt coil in one direction and through the series coil in the opposite direction.

The circuit breaker contacts consist of one movable contact mounted on an armature operated by the electro magnet, while the other is a stationary contact. These contacts are held open by an armature spring.

The sequence of operation of the circuit breaker unit is as follows:

When the generator is not running, the contacts are open. When the generator is started, the voltage builds up at the generator terminal and in the shunt coil. As soon as the voltage reaches the value for which the circuit breaker is calibrated, there is sufficient magnetism created by the shunt coil to pull down the armature, closing the contacts, automatically connecting the generator to the battery. With the contacts thus closed, the current in the series coil is flowing from the generator to the battery or in the same direction as the current in the shunt coil, so that the pull on the armature is increased by magnetism of the series coil.

As the engine is stopping and the generator loses speed, the voltage falls. As soon as the generator voltage drops below the battery terminal voltage, the current flows from the battery to the generator, reversing the direction of current in the series coil so that the magnetism created by the series coil is opposed to the magnetism created by the shunt coil, reducing the magnetic pull on the armature and the spring opens the contacts, disconnecting the generator from the battery.

MAINTENANCE PROCEDURE

1. Contacts—The contacts can be cleaned by filing, parallel with the length of the armature, with a very fine file (ST-290 recommended) so that they are free from pits or burning. After filing the contacts should be cleaned with refined carbon tetrachloride to remove any dirt or grease. Pull a piece of clean linen tape between the contacts to remove any residue.

2. Adjustments

a. Armature air gap .010 to .030 inches

This gap is measured with the contacts closed

RELAYS AND REGULATORS — Continued

and is adjusted by raising or lowering the stationary contact "A" Figure 43.

b. Contact gap .015 to .045 inches

Adjustment is made by bending the armature stop "B" Figure 43.

3. Testing and Adjusting

a. Contact closing voltage

6 volt units 6.5 to 7.25 volts

12 volt units 13 to 14.5 volts

Adjustment is made by increasing or decreasing the tension of the armature spring by bending the lower spring holder "C" Figure 43.

b. Contact opening amperage

CB and RA types— 6 volt units .5 to 2.5 amperes discharge

—12 volt units .5 to 2 amperes discharge

CBA type— 6 volt units 1.5 to 4.5 amperes discharge

—12 volt units .5 to 3.5 amperes discharge

Adjustment for contact opening amperes is made by bending the armature stop "B" Figure 43. This changes the gap of the contacts when open. The contact gap (contacts open) must not be less than .015 inches after adjustments are completed.

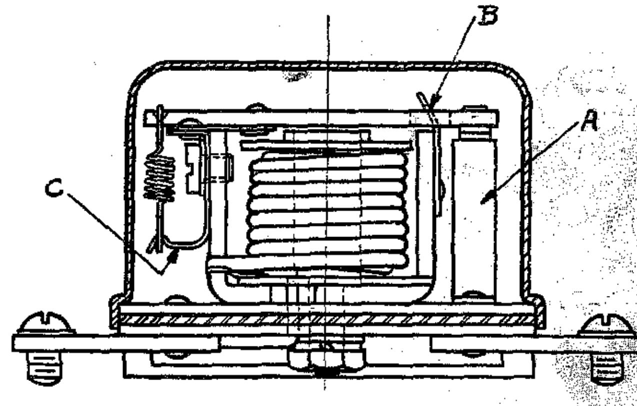


FIGURE 43

TC (TWO-CHARGE) REGULATORS

DESCRIPTION AND FUNCTION The TC-4300 series regulators are built both as a combination circuit breaker and regulator and as a regulator only. When the unit is a regulator only it is used in conjunction with a separately mounted circuit breaker. The operation of the regulator unit is identical in both types.

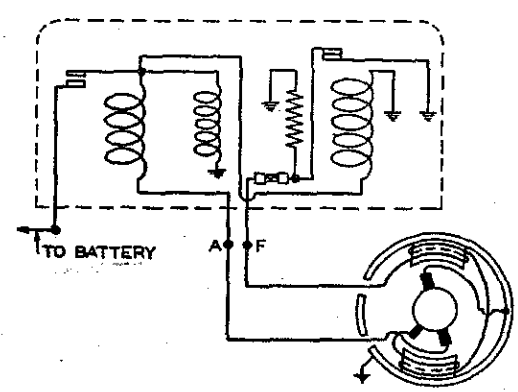


FIGURE 44

Figure 44 shows the internal wiring connections of a combination circuit breaker and TC regulator.

The operation of the circuit breaker is the same as previously described on page 40.

The TC (two charge) regulators operate on the principle of inserting a resistance in the generator field circuit when the generator voltage reaches a pre-determined value and cutting out the resistance as the voltage falls below a second pre-determined value. To meet battery characteristic changes resulting from temperature changes a magnetic by-pass is used.

The magnetic by-pass type of compensation operates by varying the amount of magnetic pull exerted on the armature at any given voltage

RELAYS AND REGULATORS — Continued

according to the temperature. The magnetic by-pass is a small piece of nickel-iron across the top of the magnet core. The magnetic conductivity of this by-pass gradually increases as its temperature is reduced. Thus at low temperatures much of the magnetic pull of the core which would normally affect the cutting in of the field resistance flows thru this by-pass instead of the regulator armature and results in a higher generator voltage being required to open the contacts and cut in the field resistance. On the other hand at high temperatures the magnetic conductivity of the by-pass is reduced thus allowing the magnetic pull of the core to have full effect on the regulator armature and cut in the field resistance at a lower generator voltage. (See Figures 45 and 46.)

All TC regulators have an easily accessible field fuse, have the resistance controlling the generator output mounted externally and a cover which seals the working parts of the unit from dust.

MAINTENANCE PROCEDURE When testing TC regulators they should be removed from the car and checked on the test bench where temperatures are known and are fairly constant. Where it is necessary that the regulator be checked on the car be sure that the car has stood in a uniform temperature for at least 15 minutes. A thermometer, with its bulb placed near the regulator, should be used whenever a check of TC regulator action is made.

The voltmeter used to check TC regulators should be graduated in .1 volt readings. If the test is made on the car a variable resistance should be connected in series in the charging circuit for proper control of the generator voltage.

1. Visual inspection

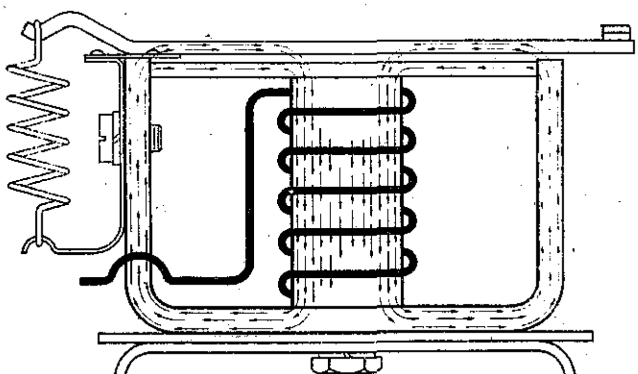
A visual inspection of the unit should be made for:

a. Evidence of burning or abnormal high temperatures at the coils, contacts, insulation, external terminals or any other point.
b. Loose connections resulting from poor soldering.
c. Loose nuts on the bottom of the magnet cores, loose rivets or screws. All nuts and screws must have lock washers.

2. Contacts

The contacts can be cleaned by filing, parallel

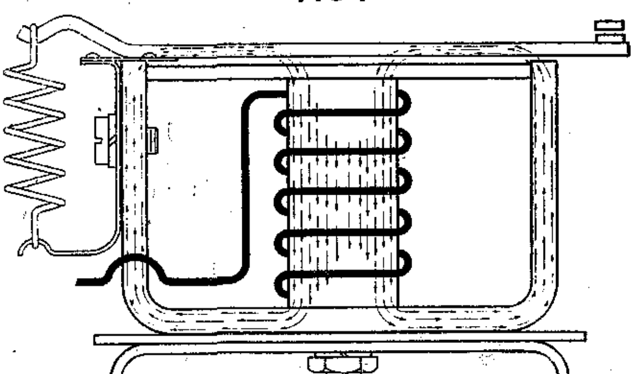
COLD



PART OF MAGNETIC LINES PASSING THROUGH MAGNETIC BY-PASS LESS PULL ON ARMATURE

FIGURE 45

HOT



ALL OF MAGNETIC LINES PASSING THROUGH ARMATURE NONE THROUGH MAGNETIC BY-PASS MORE PULL ON ARMATURE

FIGURE 46

RELAYS AND REGULATORS — Continued

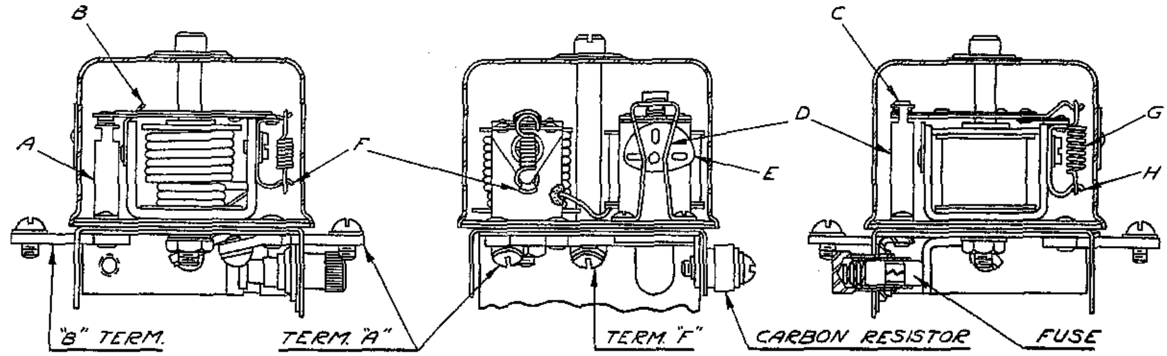


FIGURE 47

with the length of the armature, with a very fine file (ST-290 recommended) so that they are free from pits or burning. After filing the contacts should be cleaned with refined carbon tetrachloride to remove any dirt or grease. Pull a piece of clean linen tape between the contacts to remove any residue.

3. Carbon Resistor

Check the resistance of the carbon resistor with an ST-284 ohmeter. The resistance must be according to the values given in the test specifications at the end of this section.

4. Circuit Breaker Unit

a. Armature Air Gap—.010 to .030 inches

This gap is measured with the contacts closed and is adjusted by raising or lowering the stationary contact "A" Figure 47.

b. Contact Gap—.015 to .045 inches

Adjusted by bending the armature stop "B" Figure 47.

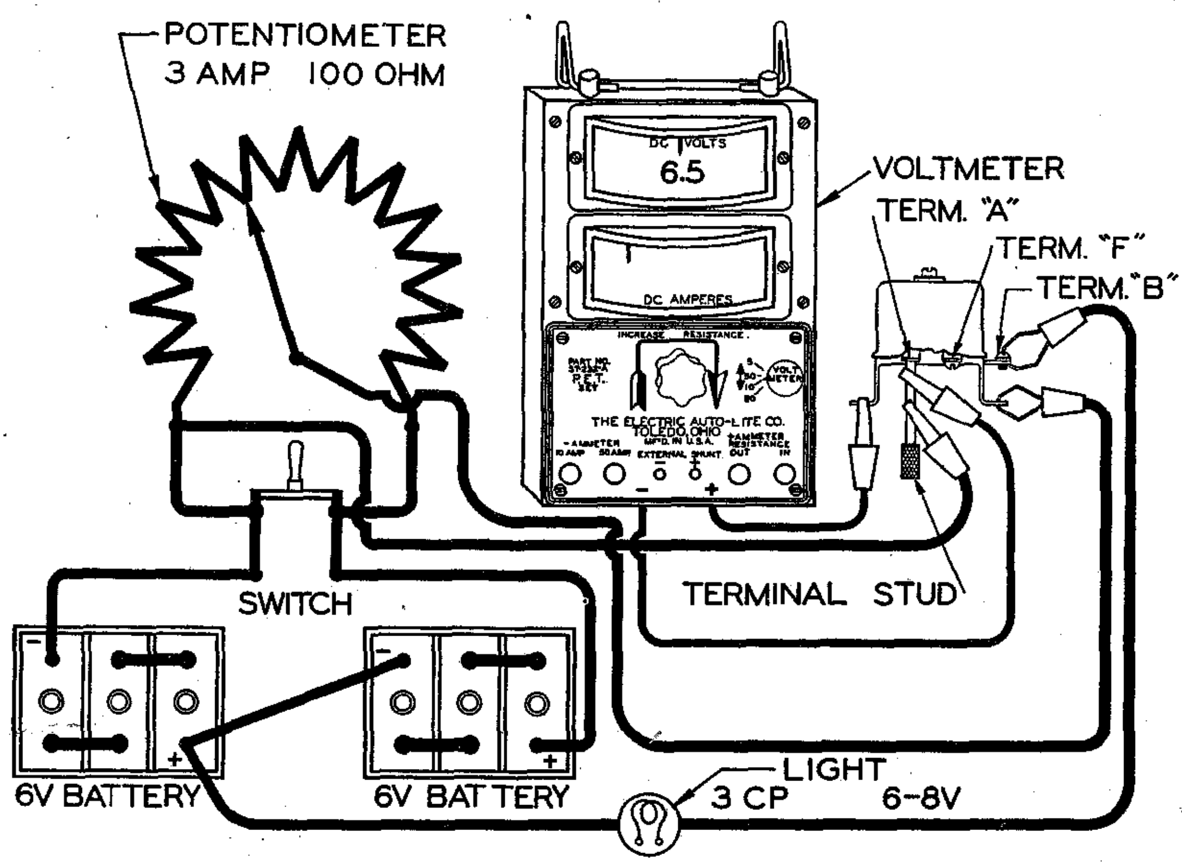


FIGURE 48

RELAYS AND REGULATORS — Continued

5. TC Regulator Unit

a. Armature Air Gap—.045 ± .001 inches

This gap is measured with the regulator or contacts closed. It can be adjusted by raising or lowering the upper contact "C" by expanding or contracting the bridge "D" holding the upper contact.

b. Contact Gap—.005 inch minimum.

Adjust by turning the brass cam "E" Figure 47.

TESTING AND ADJUSTING

1. Circuit Breaker Operation

Connect a voltmeter as shown in Figure 48. Increase the voltage from zero and note the voltage at which the contacts close as indicated by the lamp lighting. This voltage reading should be within the limits shown in the TC test specifications at the end of this section. Adjust by increasing or decreasing the tension of the armature spring by bending the lower spring holder "F" Figure 47.

2. TC Regulator Operation

Connect a voltmeter as shown in Figure 49. Increase the voltage from zero and note the voltage at which the contacts open as indicated by the lamp dimming or going out. This voltage figure should be within the test specifications for the unit being tested and at the temperature shown. Adjust by varying the tension of spring "G" Figure 47 by bending the spring hanger "H".

Reduce the voltage and check the contact closing voltage as indicated by the lamp lighting. This voltage should be within the test specifications shown. Adjust by turning the brass cam "E" Figure 47. This changes the contact gap which must not be less than .005 inch after adjustments are completed.

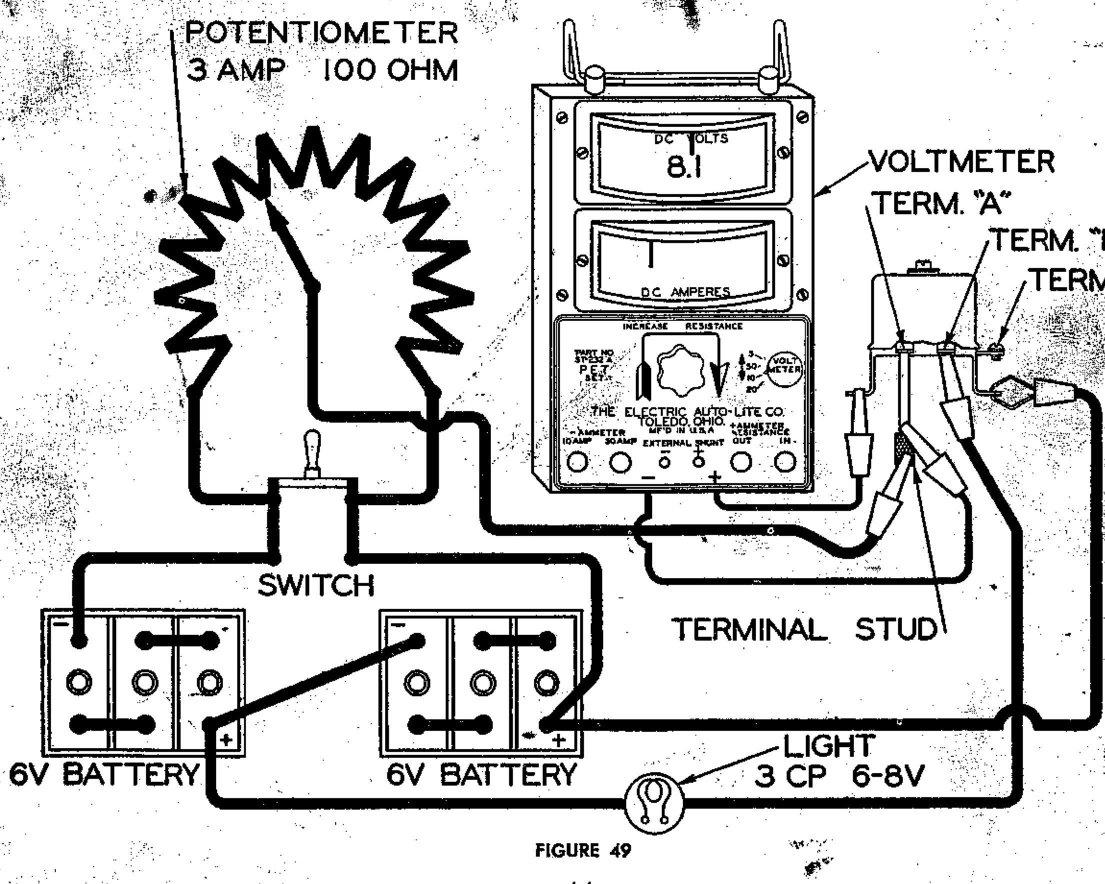


FIGURE 49

RELAYS AND REGULATORS — Continued

TC REGULATOR NUMERICAL INDEX

Part No.	Rated Volts	Test No.	Resistor*	Fuse	Part No.	Rated Volts	Test No.	Resistor*	Fuse
TC-4301A	6	1	1.4	5	TC-4310A	12	2	2.85	5
TC-4301B	6	1	1.4	5	TC-4310B	12	2	1.85	5
TC-4302A	6	1	1.85	5	TC-4311A	6	1	1.85	5
TC-4302B	6	1	1.1	5	TC-4312A	6	1	1.85	5
TC-4303A	12	2	2.85	5	TC-4313A	6	1	1.85	5
TC-4303B	12	2	2.85	5	TC-4314A	6	1	1.85	7.5
TC-4303C	12	2	1.85	5	TC-4315A	12	2	2.85	7.5
TC-4303D	12	3	11	5	TC-4316A	6	1	1.85	5
TC-4304A	6	4	1.85	5	TC-4317A	6	1	1.85	5
TC-4305A	6	1	1.85	5	TC-4318A	12	2	1.85	5
TC-4305B	6	5	1.85	5	TC-4320A	6	1	1.1	7.5
TC-4305C	6	6	1.85	5	TC-4320B	6	1	1.85	7.5
TC-4305D	6	6	5.5	5	TC-4321A	12	2	2.85	5
TC-4305E	6	6	2.85	5	TC-4322A†	12	2	1.85	5
TC-4305F	6	1	1.85	5	TC-4323A	6	7	20	5
TC-4306A	6	1	1.85	5	TC-4323B	6	7	7	5
TC-4307A†	6	4	1.85	5	TC-4324A	6	6	2.85	5
TC-4308A†	6	1	1.85	5					
TC-4309A†	6	1	1.85	5					

*Ohmic resistance is the marked value with a tolerance of ± 5%.
†No circuit breaker.

TC REGULATOR TEST DATA

TEST	1	2	3	4
CIRCUIT BREAKER				
Resistance of Voltage Winding	35-39	111-123	111-123	35-39
Armature Air Gap	.010"-.030"	.010"-.030"	.010"-.030"	.010"-.030"
Contact Point Gap	.015"-.045"	.015"-.045"	.015"-.045"	.015"-.045"
Point Closing Volts	6.5-7.25	13.0-14.5	13.0-13.5	6.5-7.25
Point Opening Amps. Discharge	.5-2.5	.5-2.0	.5-2.0	.5-2.5
VOLTAGE REGULATOR				
Resistance of Winding	29-33	102-112	102-112	29-33
Armature Air Gap	.044"-.046"	.044"-.046"	.044"-.046"	.044"-.046"
Contact Point Gap	.005" min.	.005" min.	.005" min.	.005" min.
High to Low Charge				
50°F	8.65	17.30	15.95	8.39
60°F	8.57	17.12	15.80	8.32
70°F	8.50	17.00	15.65	8.25
80°F	8.43	16.86	15.50	8.18
90°F	8.35	16.70	15.35	8.11
100°F	8.28	16.56	15.20	8.04
110°F	8.21	16.42	15.05	7.97
Tolerance	± .25	± .40	± .20	± .25
Low to High Charge	1.2 to 1.4 Volts below high to low	2.4 to 2.8 Volts below high to low	2.0 to 2.4 Volts below high to low	1.2 to 1.4 Volts below high to low

TEST	5	6	7
CIRCUIT BREAKER			
Resistance of Voltage Winding	35-39	35-39	35-39
Armature Air Gap	.010"-.030"	.010"-.030"	.010"-.030"
Contact Point Gap	.015"-.045"	.015"-.045"	.015"-.045"
Point Closing Volts	6.4-7.0	6.4-7.0	6.5-7.25
Point Opening Amps. Discharge	1.0-3.5	1.0-3.5	.5-2.50
VOLTAGE REGULATOR			
Resistance of Winding	29-33	29-33	29-33
Armature Air Gap	.034"-.038"	.044"-.046"	.047"-.049"
Contact Point Gap	.005" min.	.005" min.	.005" min.
High to Low Charge			
50°F	8.15	8.15	7.34
60°F	8.07	8.07	7.29
70°F	8.00	8.00	7.25
80°F	7.93	7.93	7.21
90°F	7.85	7.85	7.16
100°F	7.78	7.78	7.12
110°F	7.71	7.71	7.08
Tolerance	± .25	± .25	± .15
Low to High Charge	1.8 to 2.0 Volts below high to low	1.8 to 2.0 Volts below high to low	1.0 to 1.2 Volts below high to low

RELAYS AND REGULATORS — Continued

VRB, VRD, VRE, VRF, VRJ, VRK, VRO, VRP, VRR, VRS, VRT, VRU, VRV, VRW and VRX REGULATORS

DESCRIPTION AND FUNCTION While there are several types of VR regulators they all operate on the same general principle. The following description of their construction and operation is given so that in making the tests as outlined they may be made more intelligently.

The VR regulators used with third brush controlled generators have two units and two functions to perform, namely, the closing and opening of the circuit between the generator and battery by means of the circuit breaker and the holding of the voltage at a predetermined value by means of the voltage regulator unit. The current is limited by the conventional third brush action.

The VR regulators used with shunt generators have three units, each performing a distinct and independent function; 1st, the circuit breaker to close and open the circuit between the generator and battery; 2nd, the voltage regulator to hold the system voltage at a predetermined value; and 3rd, the current limiting regulator to control the maximum ampere output of the generator.

CIRCUIT BREAKER UNIT

The operation and function of the circuit breaker unit is the same as described on page 40.

VOLTAGE REGULATOR UNIT

The electromagnet of the voltage regulator unit has a single winding which is shunt connected directly across the battery charging circuit. This connection is made at the circuit breaker in order that the battery rather than generator voltage will control its operation. When the voltage rises to a predetermined value, this winding is energized sufficiently to cause the voltage regulator contacts to open, thus cutting in a resistance in the generator field circuit which reduces the generator voltage. Immediately upon the dropping of the voltage the contacts close, shorting out the resistance, and the voltage rises again thus completing one cycle of operation. These cycles occur at frequencies necessary to maintain the voltage at correct values as long as the voltage is high enough to keep the voltage regulator unit in operation. With the addition of a current load great enough to lower the battery voltage below the operating voltage of the voltage regulator, the contacts will remain closed and the generator will maintain its maximum charging rate. The voltage regulator is compensated for temperature variations through the use of a nickel-iron magnetic by-pass whereby a higher voltage is required to vibrate the contacts under cold operating conditions than is required under hot operating conditions. This is necessary as it requires a higher voltage to charge a battery when it is cold than when it is hot.

CURRENT LIMITING REGULATOR UNIT

The current limiting regulator unit used with shunt type generators has an electromagnet with a winding of heavy wire which is connected in series between the generator "A" terminal and the series winding of the circuit breaker, so that the entire output of the generator flows through it. When the generator output reaches its predetermined maximum (the ampere rating of the generator with which the regulator was designed to operate), the regulator contacts are opened, inserting a resistance in the field circuit which reduces the ampere output of the generator. Immediately upon the dropping of the output the contacts close, shorting out the resistance and the

RELAYS AND REGULATORS — Continued

output rises completing one cycle of operation. These cycles occur at sufficiently high frequency so that the output is limited to a predetermined maximum.

CAR TEST

NOTE—BEFORE ANY WORK IS DONE ON THE REGULATOR THE FOLLOWING CONDITIONS SHOULD BE CAREFULLY CHECKED AND CORRECTED IF AT FAULT:—

1. WIRING FROM GENERATOR TO REGULATOR PROPERLY CONNECTED.
2. HIGH RESISTANCE CONNECTIONS IN THE CHARGING CIRCUIT. THIS SHOULD BE CHECKED WITH AN ACCURATE READING VOLTMETER AND INSPECTED MECHANICALLY FOR POORLY SOLDERED TERMINALS AND LOOSE OR CORRODED CONNECTIONS.
3. GENERATOR PERFORMANCE WITHOUT THE REGULATOR IN THE CIRCUIT OPERATING ACCORDING TO SPECIFICATIONS.
4. THAT THE REGULATOR IS THE ONE DESIGNED FOR THE GENERATOR WITH WHICH IT IS OPERATING. THESE REGULATORS WILL FUNCTION SATISFACTORILY ONLY WHEN INSTALLED WITH THE GENERATOR DESIGNED TO OPERATE IT. ALSO BATTERY CONDITION AFFECTS REGULATOR OPERATION. AN OLD BATTERY, ONE PARTIALLY CHARGED OR ONE SUBJECTED TO EXCESSIVE HEAT WILL CAUSE HIGH CHARGING RATE; WHILE ONE SUBJECTED TO EXCESSIVE COLD, HARD PLATES, HIGH RESISTANCE SEPARATORS AND SULPHATION WILL CAUSE LOW CHARGING RATE. THE OPEN CIRCUIT TERMINAL VOLTAGE OF THE BATTERY AS WELL AS ITS SPECIFIC GRAVITY SHOULD BE CHECKED. THE CONDITION OF THE BATTERY AS TO CAPACITY, LEAKAGE, ETC. SHOULD BE CHECKED BY SEPARATE TEST AS SPECIFIED BY THE BATTERY MANUFACTURER.

The equipment needed for testing on the car includes an accurate indicating ammeter graduated in 1 ampere readings with heavy short leads, an accurate indicating voltmeter graduated in .1 volt readings and a reliable thermometer.

The resistance of the test ammeter must not exceed .1 volts at 10 amperes or .01 ohms. Instruments which have resistance higher than this will make it impossible to check or adjust the units with the necessary accuracy.

The drop in voltage from the regulator to the battery or from the generator to the regulator must not exceed .1 volt when the generator is charging 10 amperes. At this same charging rate the voltmeter should not show a reading when measured from the regulator base to the battery ground post, the generator frame to the regulator base or from the generator frame to the battery ground post.

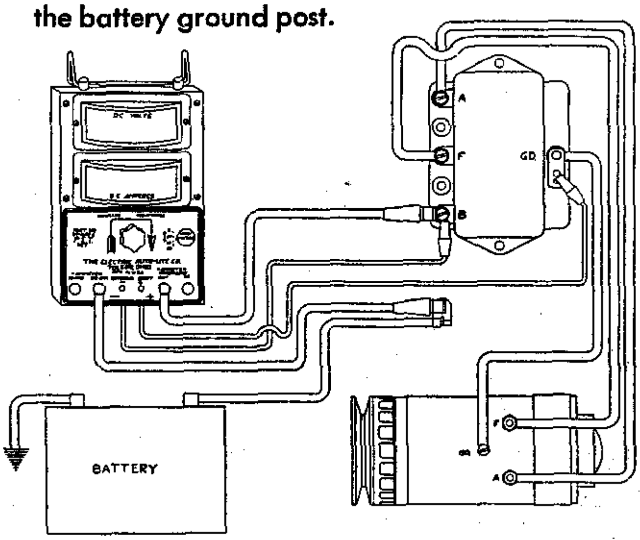


FIGURE 50

RELAYS AND REGULATORS — Continued

Connections: Disconnect the wire from the regulator "B" terminal. Connect one ammeter lead to the regulator "B" terminal and the other ammeter lead to the lead removed from this terminal as shown in Figure 50. One voltmeter lead should be connected to the regulator "B" terminal on the regulator side of the ammeter connection, while the other voltmeter lead is to be connected to the terminal marked "GD" or to the base of the regulator. (If the connections are not made in this manner, false readings will be obtained due to voltage loss in the current connections.)

The thermometer should be placed so that its bulb is approximately two inches from the side of the regulator. It must not touch the regulator.

Battery: This must read 1.275 to 1.280 specific gravity. If the car battery is discharged, substitute temporarily for test purposes a fully charged battery in good condition of the same type and capacity.

Test: Start the engine and set the throttle for a speed equivalent to approximately 30 M.P.H. Run the engine for not less than 15 minutes with the car hood up before taking meter readings. With a generator charge of 10 amperes the voltmeter should show a reading according to the specification figures given for the regulator under test at the temperature shown by the thermometer. With readings according to these figures, the voltage regulator unit can be passed as functioning correctly. See pages 65 to 70 for complete test data.

To test the current limiting regulator, the same connections as noted above are used. Add an electrical load of a current value in excess of the amperes noted on the name plate of the regulator at a point between the car ammeter and the battery. (This load may consist of a bank of standard head light bulbs or a carbon pile rheostat.) If the current limiting regulator is functioning correctly, the test ammeter will show a reading of the maximum amperes shown on the name plate of the regulator with an allowed variation of $\pm 5\%$.

If the unit does not operate according to specifications it should be removed from the car and thoroughly checked and adjusted.

MAINTENANCE PROCEDURE

VISUAL INSPECTION

Before making any tests or adjustments it is recommended that a close visual inspection be given the regulator, with special emphasis being paid to the following points:

1. Broken regulator seal.
2. Evidence of burning or abnormal high temperature at the coils, contacts, insulation, external terminals or any other point. (It is suggested that this test be made with a magnifying glass.)
3. Loose connections which result from poor soldering.
4. Loose nuts on the bottom of the magnet cores, loose rivets or screws. All nuts and screws must have lock washers.
5. Loose contacts.
6. Misalignment of contacts.
7. Bent armature either at the contact or hinge end. (The armature should be perfectly straight from one end to the other.)
8. Magnet yoke bent.
9. Bent armature hinges.
10. Reversed bimetal hinges on the circuit

RELAYS AND REGULATORS — Continued

breaker unit. (When correctly installed the brass side must be up.)

11. Stripped or crossed threads on any screw or nut.
12. Corrosion due to salt or acids.
13. Broken ground straps.
14. Evidence of water having been inside of cover.
15. Incorrect, bent or distorted armature spring. In case of doubt it is recommended that the spring be replaced.
16. Broken or altered carbon resistors.
17. Broken gaskets.
18. Incorrect wiring connections between units.

See pages 65 to 70 for complete test data on VR type regulators.

CONTACTS

The contacts should be cleaned by filing, parallel with the length of the armature, with a very fine file (ST-290 recommended) so that they are free from pits or burning. After filing the contacts should be cleaned with refined carbon tetrachloride to remove any dirt or grease. Pull a clean piece of linen tape between the contacts to remove any residue.

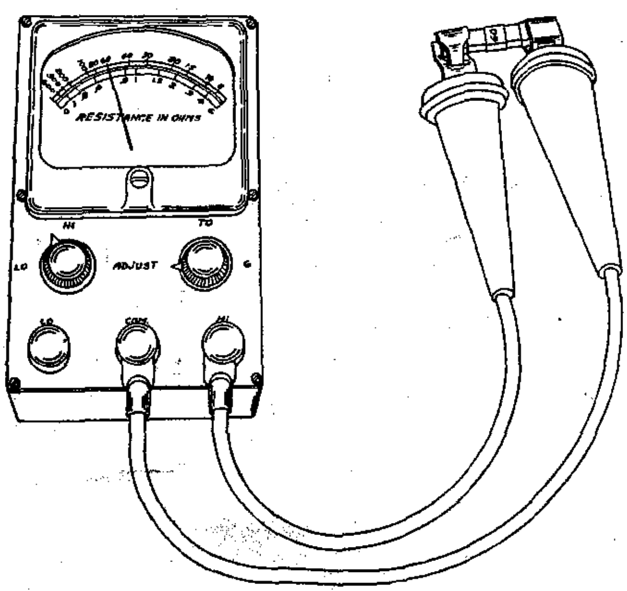


FIGURE 51

CARBON RESISTORS

1. Check the resistance of the carbon resistors. They should be removed from the regulator and checked with ST-284 ohmeter. See Figure 51.

On those regulators having more than one resistor it is extremely important that they be replaced in their proper position.

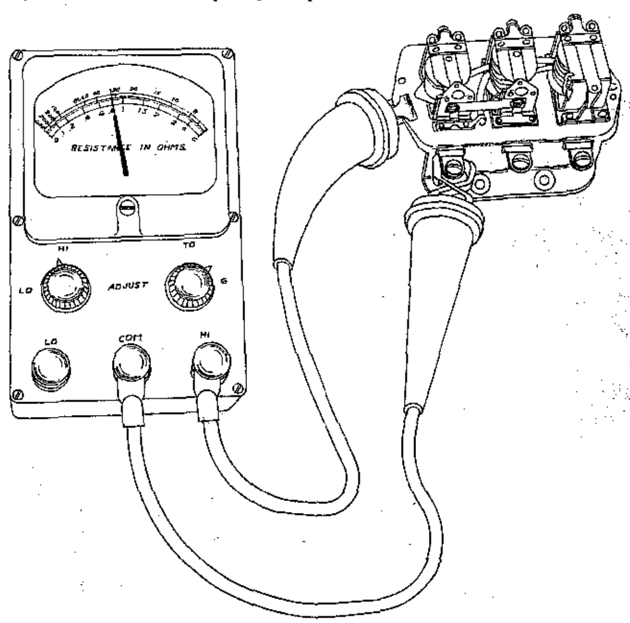


FIGURE 52

CIRCUIT BREAKER UNIT

2. Check resistance of circuit breaker voltage winding.

An accurate reading ohmeter (ST-284) is needed for this test and is made by disconnecting the voltage regulator lead from the circuit breaker yoke and measuring from the "A" terminal to a ground on the base. Connections are shown in Figure 52.

3. Check the armature air gap with the contacts open.

Use flat gauge (ST-281-3) .034" to .038" be-

RELAYS AND REGULATORS — Continued

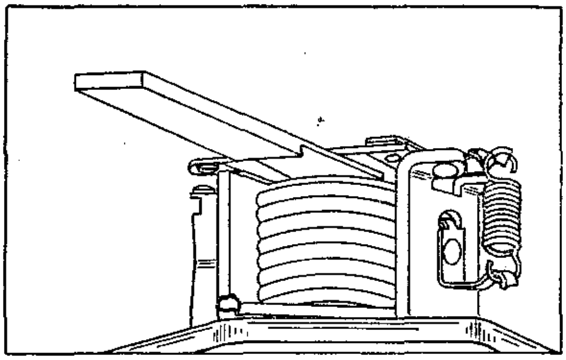


FIGURE 53

tween the magnet core and the armature as close to the hinge as possible as shown in Figure 53..

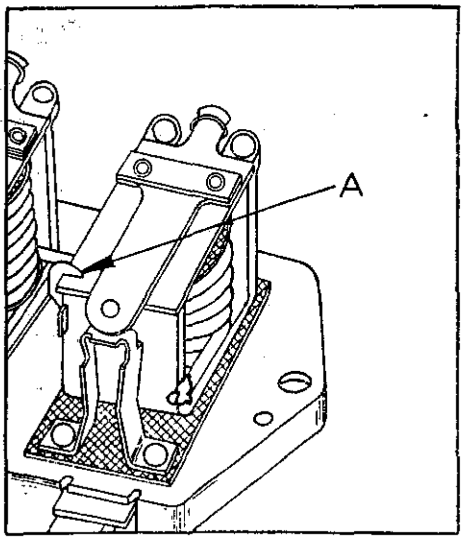


FIGURE 54

Adjustment of the air gap is made by bending the armature stop "A" Figure 54 making sure that

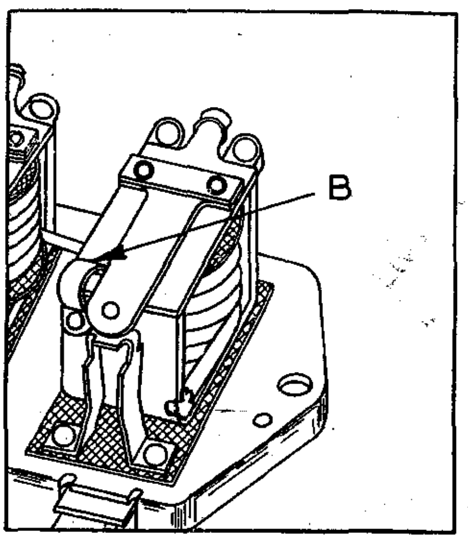


FIGURE 55.

it does not rub against the side of the armature.

On early production regulators the armature stop was at the end of the armature as shown in Figure 55. To adjust bend this stop "B" being sure that it does not rub against the end of the arma-

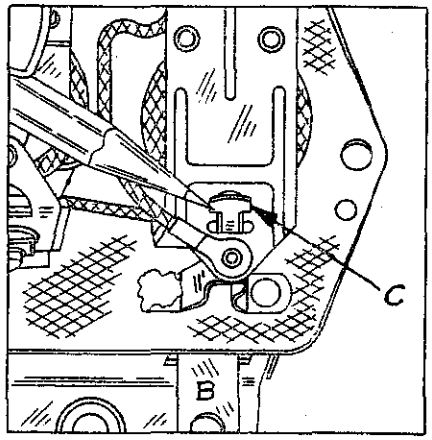


FIGURE 56

ture. Other early regulators had the armature stop in the center as is shown in Figure 56. On this type bend the stop "C" being sure it does not rub against the side of the slot.

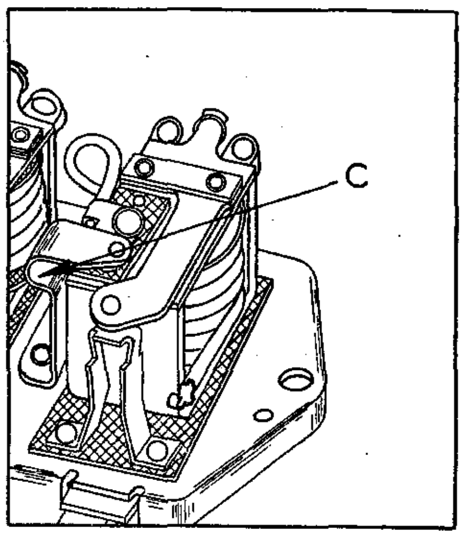


FIGURE 57

On those applications where an indicating lamp is used instead of an ammeter the regulator circuit breaker unit has a second set of contacts. To adjust the armature air gap on this type of unit bend the upper contact bracket "C" Figure 57 as required. BE SURE THAT THE BRACKET

RELAYS AND REGULATORS — Continued

SUPPORTING THE UPPER CONTACT DOES NOT RUB AGAINST THE SIDE OF THE ARMATURE OR TOUCH THE YOKE AND THAT THE CONTACTS ARE ALIGNED.

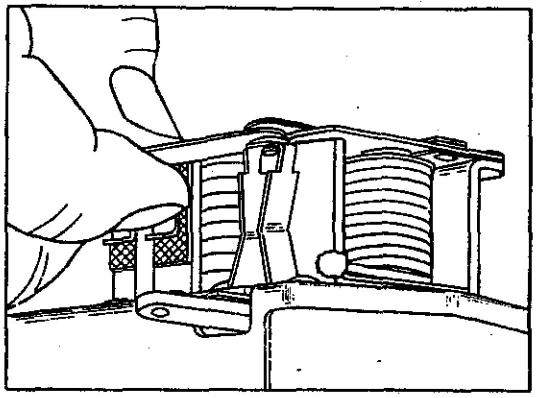


FIGURE 58

4. Check the gap of the contacts when open. See Figure 58.

This gap should be .015" minimum, but will possibly be more than this in actual adjustment.

Adjust by expanding or contracting the bridge supporting the stationary contact, being sure that the contacts are perfectly aligned. This adjustment is shown in Figure 59.

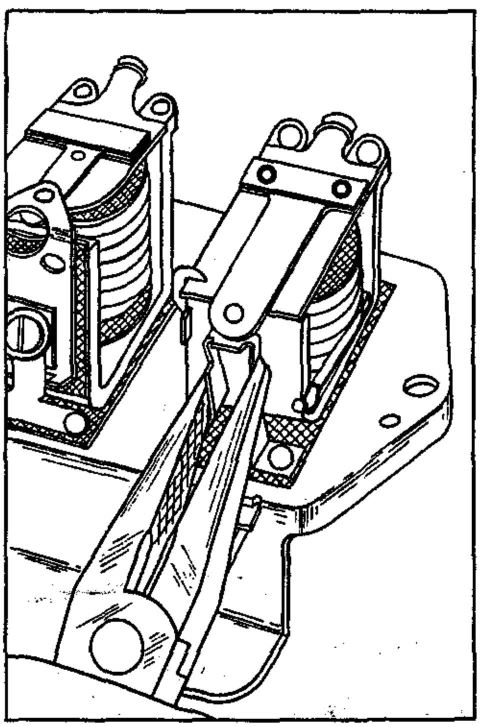


FIGURE 59

VOLTAGE REGULATOR

5. Check the resistance of the winding.

An accurate reading ohmeter (ST-284) is needed for this test. To test measure from the lead disconnected from the circuit breaker yoke to ground. See Figure 60 for these connections.

6. Check and see that the spring upon which the movable contact is mounted is straight and that it is approximately parallel with the armature.

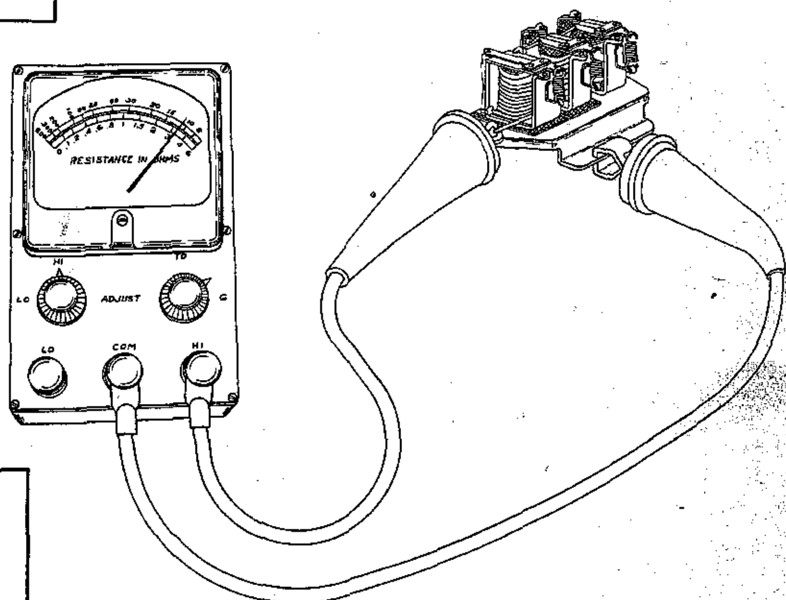


FIGURE 60

7. Check armature air gap.

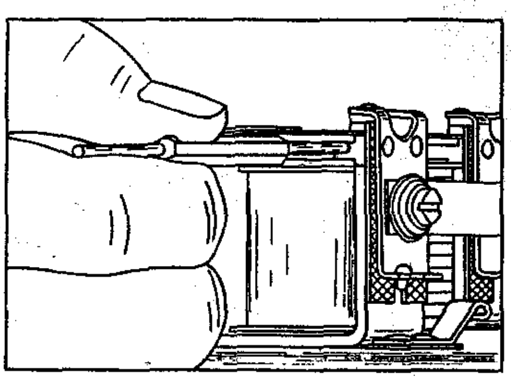


FIGURE 61

Test with pin gauge. This is to be measured on the contact side as shown in Figure 61 and next

RELAYS AND REGULATORS — Continued

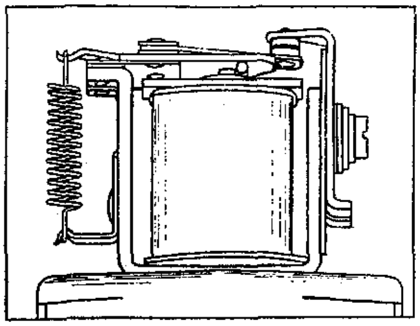


FIGURE 62

to the armature stop pin as shown in Figure 62.

To test connect a 3 C.P. test light as shown in Figure 63 in series with the "F" terminal, the regulator base and a battery. With the low limit pin gauge in place depress the armature and the light should go out or dim. With the high limit gauge in place the light should stay lighted when the armature is depressed. Use two fingers (see Figure 64) to depress the armature being careful not to touch the contact spring.

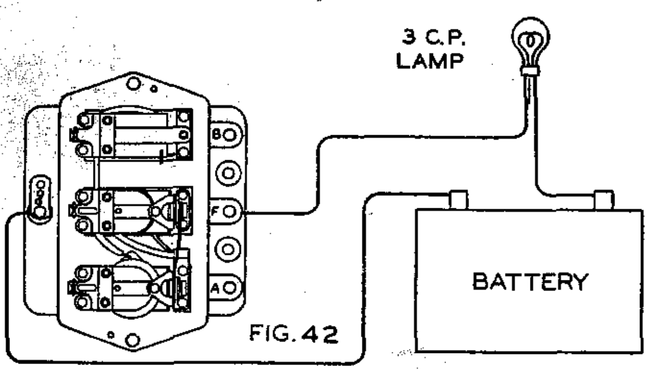


FIGURE 63

To adjust slightly loosen the screw holding the upper contact bracket and using ST-282 to raise the bracket (see Figure 65) and tapping the top of the bracket to lower the contact. Keep the contacts in perfect alignment when adjusting.

Be sure that the screws are tightened with suitable lock washers and re-check the gap after tightening the bracket screws.

Re-install the spiral spring, being sure that the correct spring is used and that both ends of the spring are down in the holding grooves and that the lower spring bracket is not distorted so that the spring is not vertical.

CURRENT LIMITING REGULATOR UNIT

8. Check and see that the spring upon which the movable contact is mounted is straight and

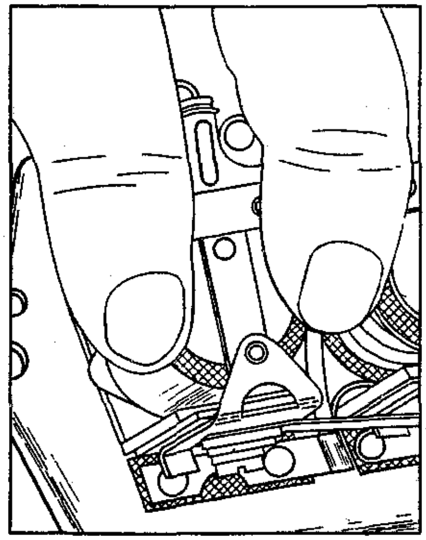


FIGURE 64

that it is approximately parallel with the armature.

Re-install the spiral spring, being sure that the correct spring is used and that both ends of the spring are down in the holding grooves, and that the lower spring bracket is not distorted so that

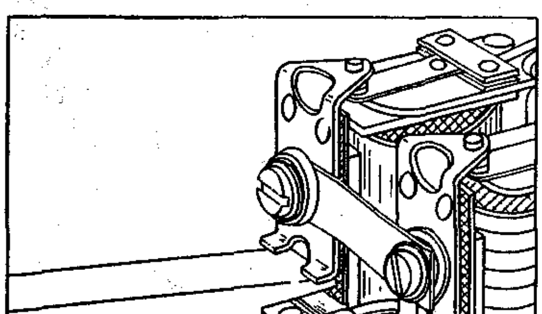


FIGURE 65

RELAYS AND REGULATORS — Continued

the spring is not vertical.

9. Check armature air gap.

Test with pin gauge. This is to be measured on the contact side as shown in Figure 61 and next to the armature stop pin as shown in Figure 62.

To test connect a test light as shown in Figure 63 in series with the "F" terminal, the regulator base and a battery. With the low limit pin gauge in place depress the armature and the light should go out or dim. With the high limit gauge in place the light should stay lighted when the armature is depressed. Use two fingers (see Figure 64) to depress the armature being careful not to touch the contact spring.

To adjust slightly loosen the screw holding the upper contact bracket and using ST-282 to raise the bracket (see Figure 65) and tapping the top of the bracket to lower the contact. Keep the contacts in perfect alignment when adjusting.

Be sure that the screws are tightened with suitable lock washers and re-check the gap after tightening the bracket screws.

10. Check the contact gap with the armature against the stop pin. (See Figure 66)

Hold the armature down with two fingers being careful not to apply pressure to the spring supporting the lower contact.

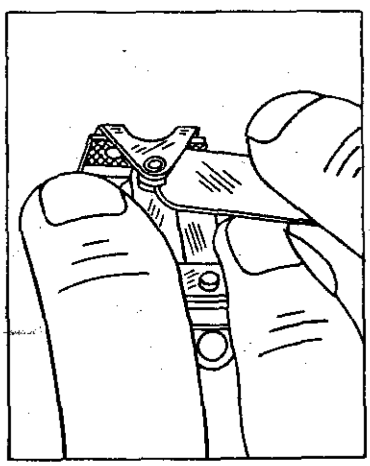


FIGURE 66

The test figures are approximate only; too much variation indicates wrong length to the armature stop pin and a new unit will be needed.

RE-ASSEMBLING THE REGULATOR

When all preceding checks and adjustments have been completed, all the leads which have been disconnected either by the removal of a screw or by unsoldering should be re-connected. Where resoldering is necessary care must be taken that a good clean contact is made. Do not use acid for soldering flux.

After the regulator has been completely reassembled, its bottom should be struck sharply on the bench several times to be sure that all parts are settled in place. Then re-check all adjustments.

TESTING AND ADJUSTING

NOTE:—THE COVER MUST BE ON THE REGULATOR WHEN TAKING READINGS OR WHEN THE UNIT IS BEING HEATED BY OPERATION PRIOR TO TAKING READINGS. THIS IS NECESSARY DUE TO THE FACT THAT THE COVER FORMS PART OF THE MAGNETIC FIELD AND ALSO HELPS TO RETAIN THE HEAT.

When testing or adjusting regulators, care must be taken that it is mounted firmly and in a place where there is no vibration. It must also be tested in the same position as it is mounted on the car.

Care must be taken in making the various test connections that these connections are firmly made so that the resistance of all connections does not exceed .01 ohms.

RELAYS AND REGULATORS — Continued

HEAT THE REGULATOR BY OPERATING IT FOR 15 MINUTES WITH THE GENERATOR CHARGING 10 AMPERES. WHILE HEATING HAVE THE COVER ON THE UNIT.

1. Check circuit breaker operation.

First Method—For circuit breakers having the upper contact mounted on a spring.

When making this test the voltmeter is connected between the "A" terminal of the regulator and a ground on the regulator base. See Figure 67.

To obtain the settings increase the voltage until the contacts close but the armature does *not seal* to the yoke. Take the contact closing voltage at this stage. Without increasing the voltage beyond that required to close the contacts decrease the voltage until the contacts open.

Second Method—For circuit breakers with the upper contact mounted directly on the armature.

To test, connect an ammeter in series between the battery and the "B" terminal. The voltmeter is connected to the "A" terminal of the regulator

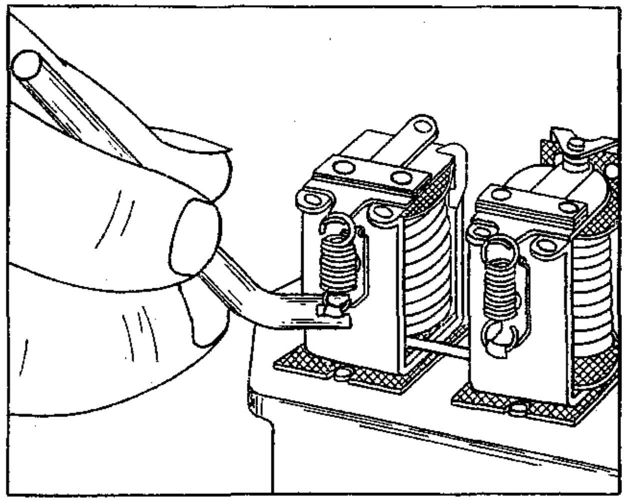


FIGURE 68

and to ground. Be sure that the voltmeter connections are on the regulator side of the ammeter connections to avoid loses due to poor connections. See Figure 67. When testing increase the voltage slowly noting the voltmeter reading just before the contacts close. Increase the charging rate to 15 amperes then reduce the charging rate noting the amperage discharge just before the contacts open.

ADJUSTMENTS

To adjust the closing voltage adjust the arma-

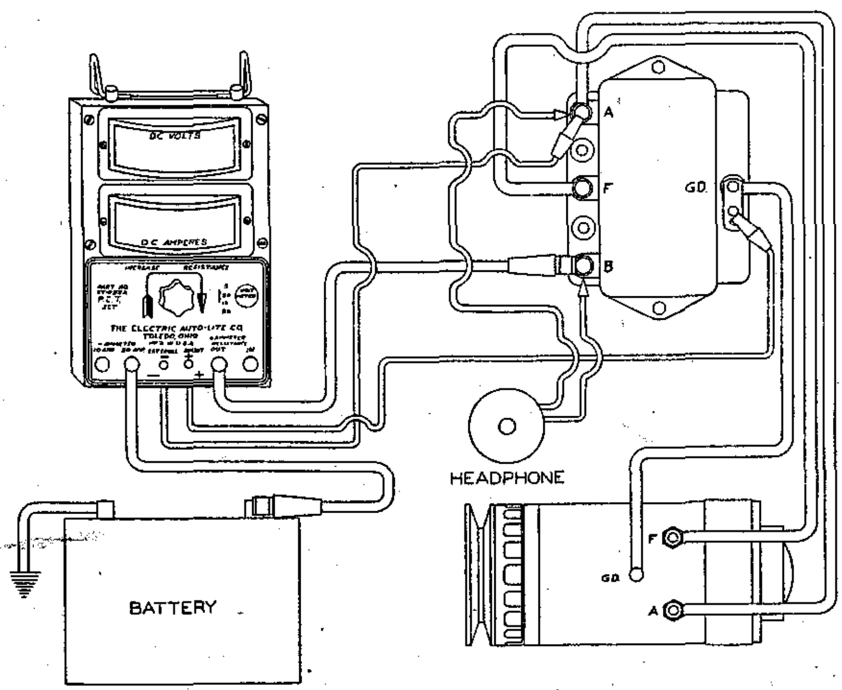


FIGURE 67

RELAYS AND REGULATORS — Continued

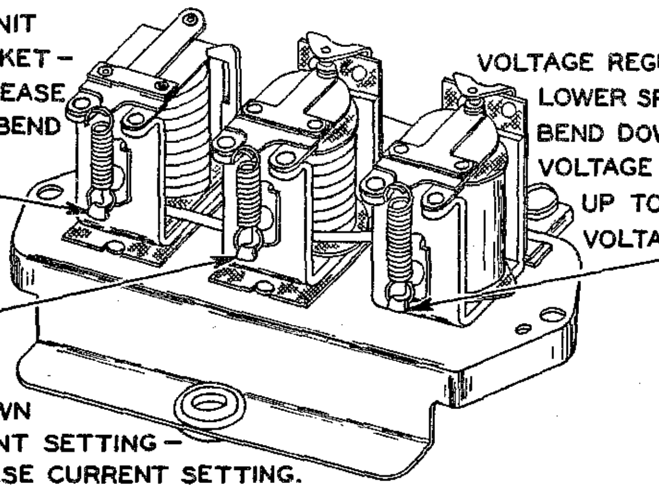


FIGURE 69

ture spring tension by bending the lower spring bracket with ST-283 as shown in Figure 68. A very accurate method of checking this closing voltage is by connecting a headphone (2000 ohms or higher) between the "B" terminal and the "A" terminal and taking the reading just as the click caused by the closing of the contacts is heard. (See Figure 67, 69 and 70)

To adjust the opening voltage or amperage adjust the contact gap by raising or lowering the stationary contact.

There must always be .5 volts less voltage at which the circuit breaker closes than the voltage at which the voltage regulator operates.

After each adjustment replace the regulator cover and again test the circuit breaker action

2. Check voltage regulator unit.

In making this test an accurate voltmeter must be used. It is to be connected to the regulator "B" terminal and to the regulator base as shown in Figure 71.

To adjust its operation, increase or decrease the armature spring tension by bending the lower spring arm with ST-283. (See Figures 69 and 70)

Replace the cover after each adjustment. Take a flash reading by stopping the generator and noting the maximum voltage reading when the generator is re-started at approximately 10 am-

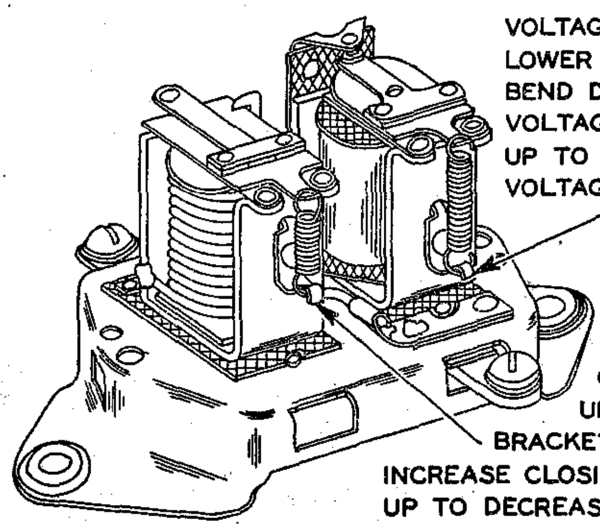


FIGURE 70

RELAYS AND REGULATORS — Continued

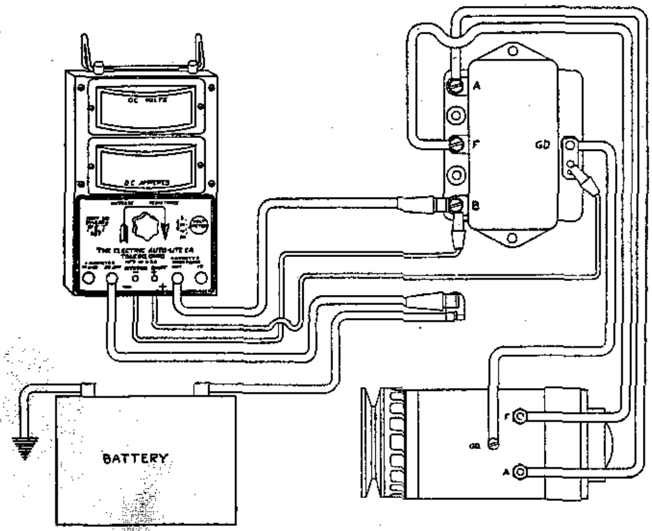


FIGURE 71

peres output with voltage regulator operating.

3. Check current limiting regulator unit.

Connect the test ammeter in series between the regulator "B" terminal and the battery.

Increase the load on the generator by placing a lamp bank or other suitable resistance across the battery on the battery side of the ammeter.

The ammeter should read within 5% of the amperage stamped on the nameplate of the regulator.

If the amperage is outside the limits adjust the current regulator unit by varying the spring tension. This is done by bending the lower spring bracket with ST-283. (See Figure 69) Replace the cover after each adjustment and make a flash test.

POLARIZING

Generators should always be polarized before running on car or bench. Do not polarize the generator by holding the circuit breaker contacts closed. Use a jumper from the starting switch battery connection to the "A" terminal of the generator. The excessive current in closing the circuit breaker contact for this purpose may result in burnt contacts.

VRA, VRC, VRG, VRH AND VRY REGULATORS

DESCRIPTION AND FUNCTION These regulators are of the heavy duty type. The Description and Function and Car Test found on pages 46 to 48 of this section is equally applicable to the heavy duty type regulators. The main difference is the size and the fact that on some of the heavy duty regulators a second winding is used on the current limiting regulator. This second winding is connected in series with the generator field circuit and is connected so that the rise and fall of the field current accelerates the action of the current regulator armature. This causes the cycles of operation to occur at sufficiently high frequencies to limit the output to minimum fluctuation.

MAINTENANCE PROCEDURE

VISUAL INSPECTION

Before making any tests or adjustments it is recommended that a close visual inspection be given the regulator, with special emphasis being paid to the following points:

1. Broken regulator seal.
2. Evidence of burning or abnormal high temperature at the coils, contacts, insulation, external terminals or any other point. (It is suggested that this test be made with a magnifying glass.)
3. Loose connections which result from poor soldering.

RELAYS AND REGULATORS — Continued

4. Loose nuts on the bottom of the magnet cores, loose rivets or screws. All nuts and screws must have lock washers.
5. Loose contacts.
6. Misalignment of contacts.
7. Bent armature either at the contact or hinge end. (The armature should be perfectly straight from one end to the other.)
8. Magnet yoke bent.
9. Bent armature hinges.
10. Reversed bimetal hinges on the circuit breaker unit. (When correctly installed the brass side must be up.)
11. Stripped or crossed threads on any screw or nut.
12. Corrosion due to salt or acids.
13. Evidence of water having been inside of cover.
14. Incorrect, bent or distorted armature spring. In case of doubt it is recommended that the spring be replaced.
15. Broken or altered carbon resistors.
16. Broken gaskets.
17. Incorrect wiring connections between units.
18. Shunt leads and terminal on circuit breaker armature must be free and not interfere with armature movement or touch tension spring.

See pages 65 to 70 for complete test data on VR type regulators.

CONTACTS

The contacts should be cleaned by filing, parallel with the length of the armature, with a very fine file (ST-290 recommended) so that they are free from pits or burning. After filing the contacts should be cleaned with refined carbon tetrachloride to remove any dirt or grease. Pull a clean piece of linen tape between the contacts to remove any residue.

CARBON RESISTORS

Check the resistance of the carbon resistors. These resistors are found on the under side of the regulator base and should be removed and checked one at a time in order to avoid any interchanging. Use an accurate ohmeter for checking the resistance.

CIRCUIT BREAKER

1. Check resistance of circuit breaker voltage winding.

An accurate ohmeter is needed for this test. This test is made by disconnecting the voltage winding ground connection and measuring from the lead to the stationary contact.

2. Check the armature air gap with the contacts open.

Use flat gauge inserted on the contact side of the brass pin in the core as shown in Figure 72.

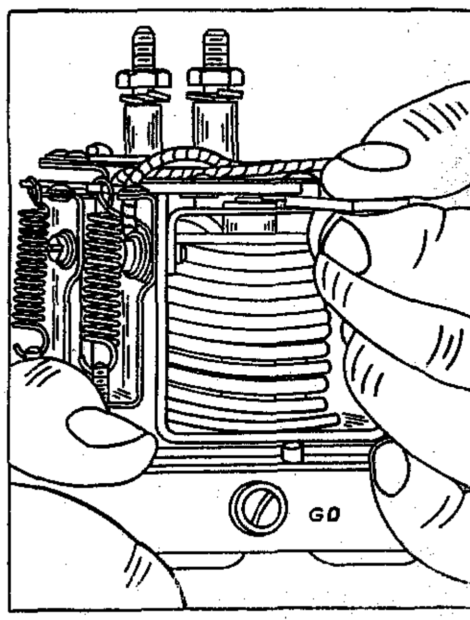


FIGURE 72

RELAYS AND REGULATORS — Continued

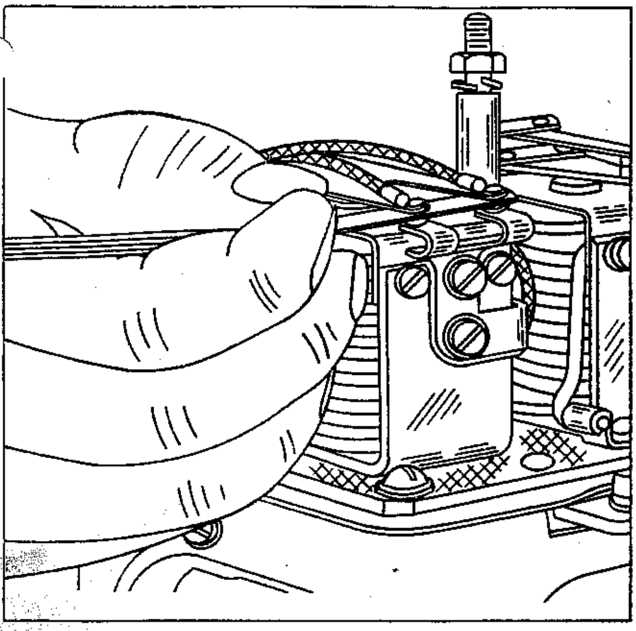


FIGURE 73

Adjust by raising or lowering the stop at the contact end of the armature.

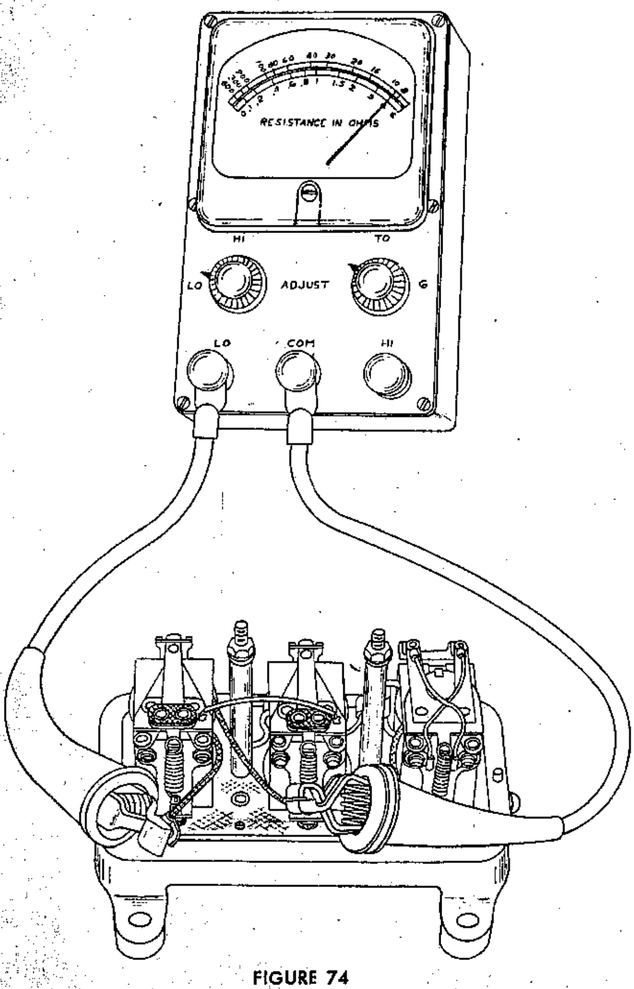


FIGURE 74

3. Check gap of the contacts.

This gap should be .015" minimum, but will possibly be more than this in actual adjustment. (See Figure 73)

Adjust by bending the supporting arms of the stationary contacts, being sure that both sets of contacts are in perfect alignment and that contact is made on both sets of contacts at the same time. Use a straight edge across the top of the contact brackets to check their alignment.

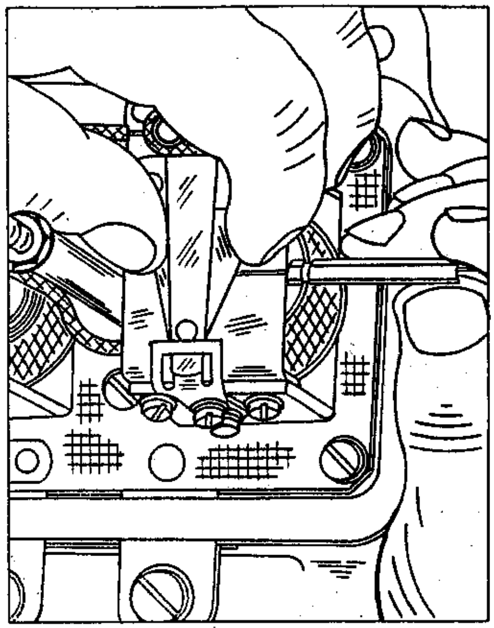


FIGURE 75

VOLTAGE REGULATOR

4. Check the resistance of the winding.

An accurate ohmeter is needed for this test. To test disconnect both leads from the base and measure between the terminals as shown in Figure 74.

5. Check armature air gap with contacts just breaking.

Test with pin gauge as shown in Figure 75. This measurement is to be taken on the contact side and next to the brass armature stop pin as illustrated in Figure 76.

RELAYS AND REGULATORS — Continued

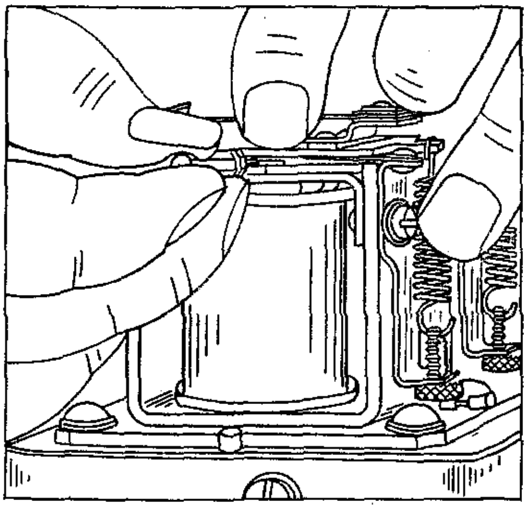


FIGURE 76

To test connect a 3 C.P. light as shown in Figure 77 in series with the "A" and "F" terminals and a battery. With the low limit pin gauge in place, depress the armature and the light should go out.

With the high limit pin gauge in place, depress the armature and the light should stay lighted. Use two fingers in depressing the armature, one

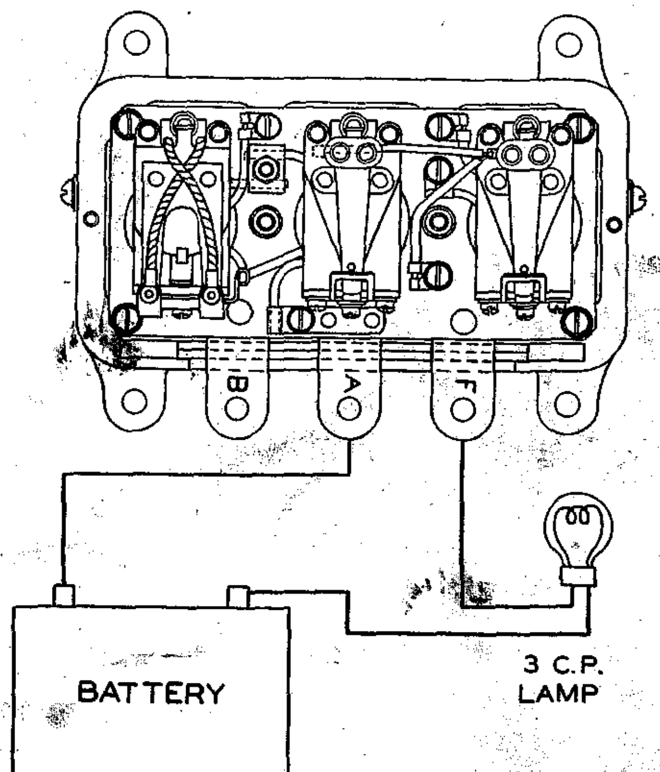


FIGURE 77

on either side of the contact spring, so that the contact spring, is not touched. The pressure should be applied near the center of the armature.

To adjust loosen the screws and raise or lower the armature contact stop.

Be sure that these screws are tightened with suitable lock washers.

Check and see that the spring upon which the movable contact is mounted is straight and that it is parallel with the armature.

6. Check contact gap with the armature against the stop pin. Figure 78.

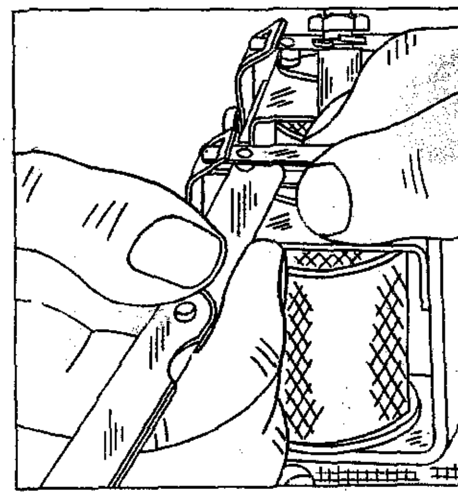


FIGURE 78

Hold the armature down with two fingers as illustrated taking care that the contact spring is not touched.

If the gap is too small check to see that the bridge carrying the nickel-iron shunt has been pushed down in assembly. If the bridge is not pushed down the armature rivets will strike the shunt and prevent the contacts from opening sufficiently.

The test figures shown are approximate only; too much variation indicates wrong length to armature stop pin and a new unit will be needed.

RELAYS AND REGULATORS — Continued

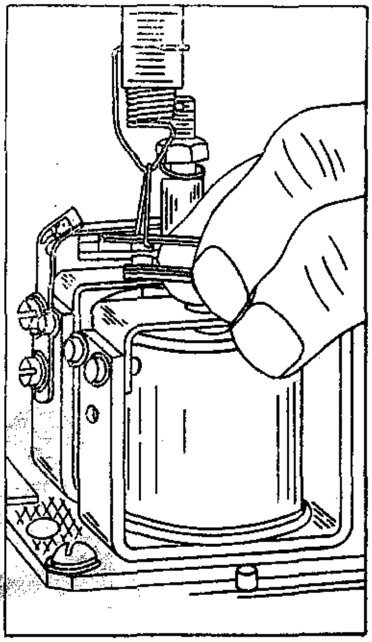


FIGURE 79

7. Check the pressure of the contacts.

To test, disconnect the spiral spring from the armature and remove the adjustable armature stop. Using a spring scale as shown in Figure 79 and holding the armature firm, take a reading just as the contacts separate.

When re-assembling the armature stop, be

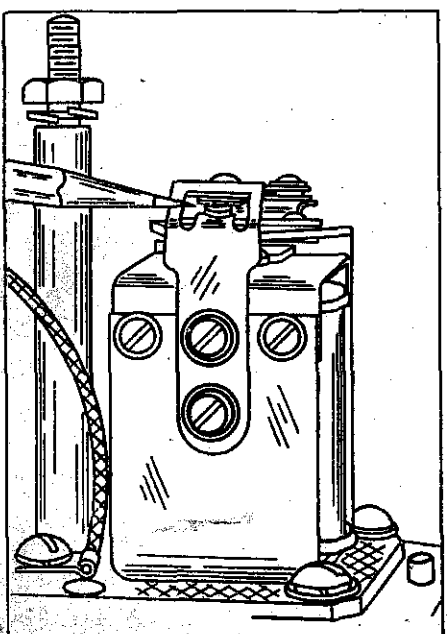


FIGURE 80

sure that the fibre bumper block is in place. See Figure 80.

CURRENT LIMITING REGULATOR

8. Check the resistance of the frequency winding. An accurate ohmeter (ST-284) is needed for this test.

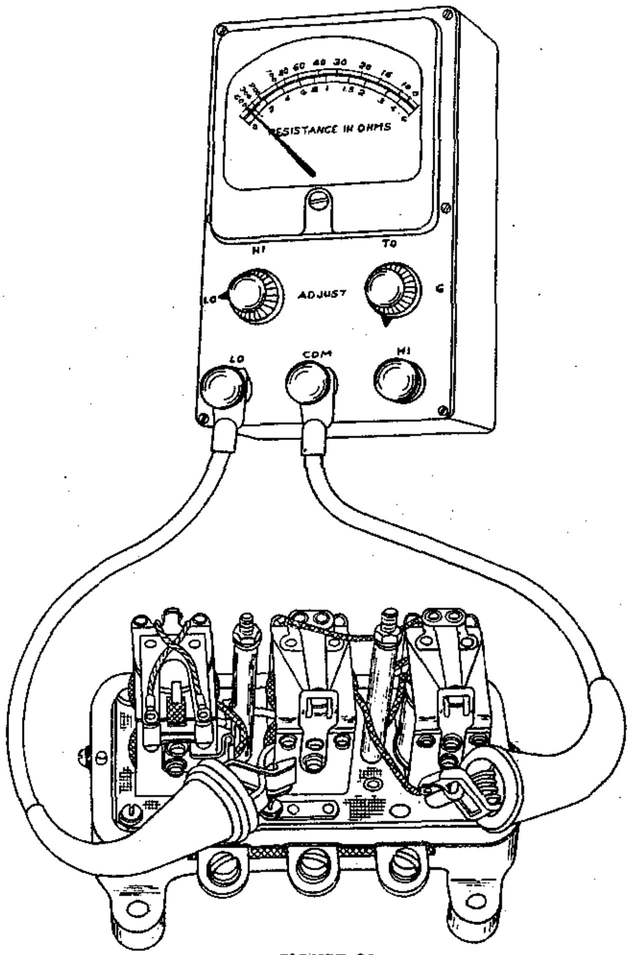


FIGURE 81

To test, disconnect the lead from the current regulator unit where it is connected to the resistor through the sub base between the current and voltage regulators and measure from this lead to the current regulator yoke. See Figure 81.

When re-assembling the armature stop, be sure that the fibre bumper block is in place. See Figure 80.

9. Check the pressure of the contacts.

RELAYS AND REGULATORS — Continued

To test, disconnect the spiral spring from the armature and remove the adjustable armature stop. Using a spring scale as shown in Figure 79 and holding the armature firm, take a reading just as the contacts separate.

When re-assembling the armature stop be sure that the fibre bumper block is in place. See Figure 80.

10. Check armature air gap with the contacts just breaking.

Test with pin gauge. This is to be measured on the contact side of the brass armature stop pin as shown in Figure 76.

To test connect a 3 C.P. light in series with the "A" and "F" terminals and a battery as illustrated in Figure 77. With the low limit pin gauge in place depress the armature and the light should go out. With the high limit pin gauge in place the light should stay lighted. Use two fingers in depressing the armature, one on either side of the contact spring, so that the contact spring is not touched. The pressure should be applied near the center of the armature.

To adjust loosen the screws and raise or lower the armature stop.

Be sure these screws are tightened with suitable lock washers.

The spring upon which the movable contact is mounted should be straight and parallel with the armature.

11. Check contact gap with the armature against the stop pin. Figure 78.

Hold the armature down with two fingers as illustrated.

Test figures shown for this gap are approximate only. Too much variation indicates wrong length to armature stop pin and a new unit will be needed.

RE-ASSEMBLING THE REGULATOR

When all the preceding checks and adjustments have been completed, all the leads which have been disconnected either by the removal of a screw or by unsoldering should be reconnected. Where resoldering is necessary, care must be taken that a good clean contact is made. Do not use acid for soldering flux.

After the regulator has been completely re-assembled, its bottom should be struck sharply on the bench several times to be sure that all parts are settled in place. When doing this be sure that it is struck squarely on all four mounting lugs. Re-check all adjustments.

TESTING AND ADJUSTING

NOTE:—THE COVER MUST BE ON THE REGULATOR WHEN TAKING READINGS OR WHEN THE UNIT IS BEING HEATED BY OPERATION PRIOR TO TAKING READINGS. THIS IS NECESSARY DUE TO THE FACT THAT THE COVER HELPS RETAIN THE HEAT.

When testing or adjusting regulators, care must be taken that it is mounted firmly and in a place where there is no vibration. It must also be tested in the same position as it is mounted on the car.

Care must be taken in making the various test connections that these connections are firmly made so that the resistance of all connections does not exceed .01 ohms with a 10 ampere charge. It is for this reason that spring clip connections are not recommended. Flexible cables which have flat spade type terminals are recom-

RELAYS AND REGULATORS — Continued

mended, as experience shows that these prevent high resistance connections from entering into the test circuit.

It is suggested that a single earphone (2000 ohms or higher) be attached to the "F" terminal and ground and used for listening to the regulator armature vibrations and so obtain an accurate indication of the operation of the current limiting and voltage regulator units.

Heat the regulator by operating it for 15 minutes with the generator charging 10 amperes. While heating the regulator have the cover on the unit.

1. Check circuit breaker operation.

To test, connect the ammeter in series between the battery and the "B" terminal. The voltmeter is connected to the "A" terminal of the regulator and to ground. Be sure that the voltmeter connections are on the regulator side of the ammeter connections to avoid losses due to poor connections. See Figure 82.

To adjust the contact closing voltage adjust the armature spring tension by adjusting the screw "A" Figure 83 which holds the lower end of the spring. A very accurate method of checking the contact closing voltage is by connecting a headphone (2000 ohms or higher) between the "A" and "B" terminals of the regulator as shown in Figure 82 and observe the voltage at which the click, caused by the closing of the contacts, is heard.

To adjust the contact opening amperage, adjust the contact gap by raising or lowering the stationary contacts.

After each adjustment, replace the regulator cover and again test the circuit breaker operation.

There should always be .5 volts less voltage at

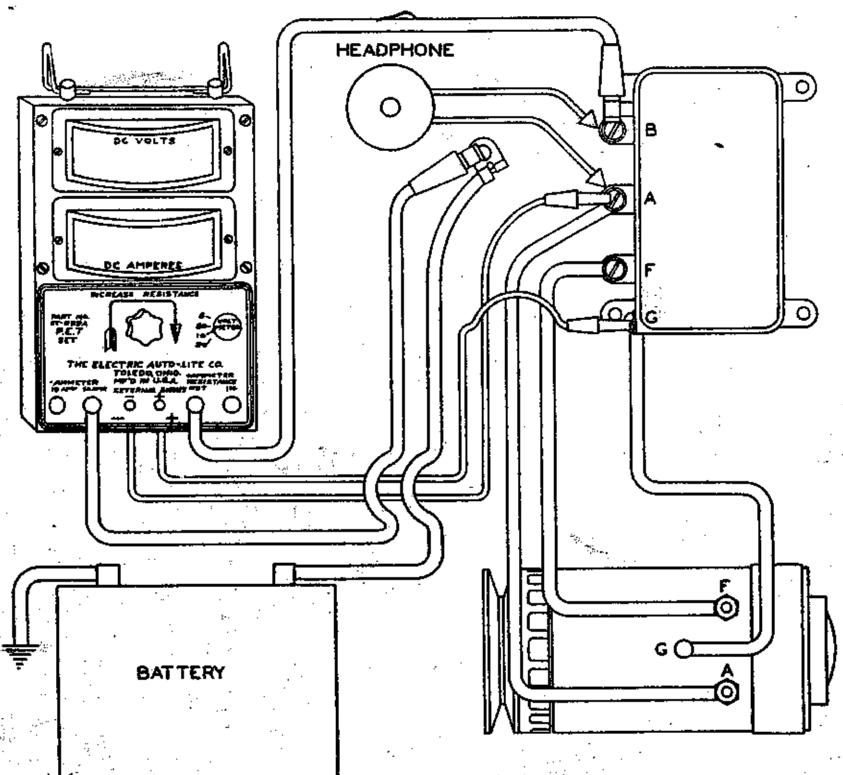


FIGURE 82

RELAYS AND REGULATORS — Continued

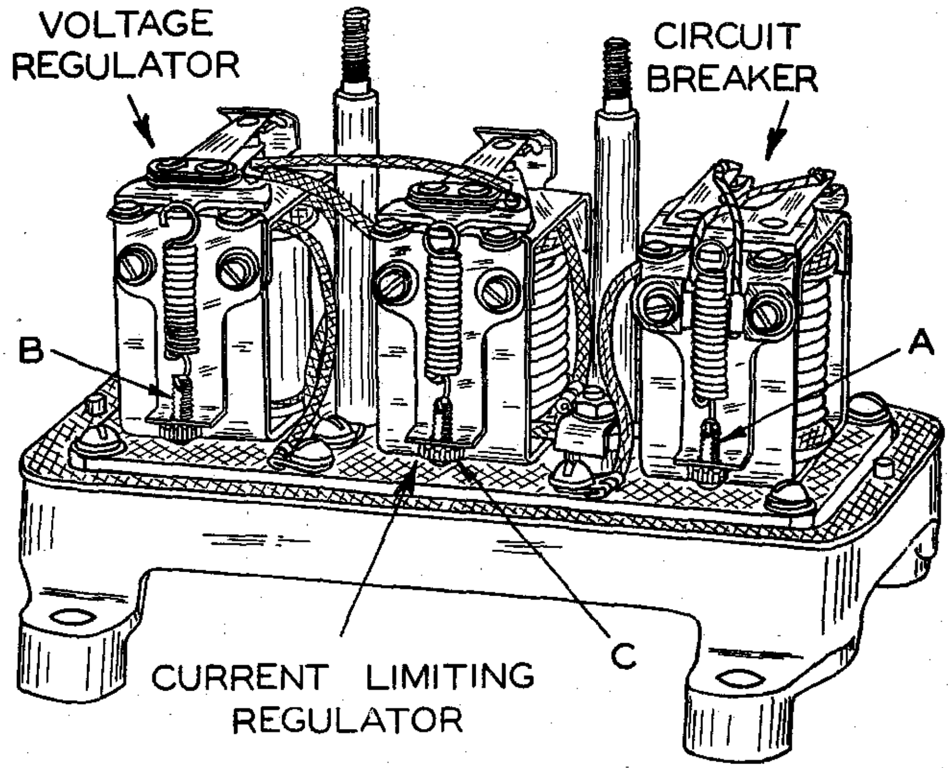


FIGURE 83

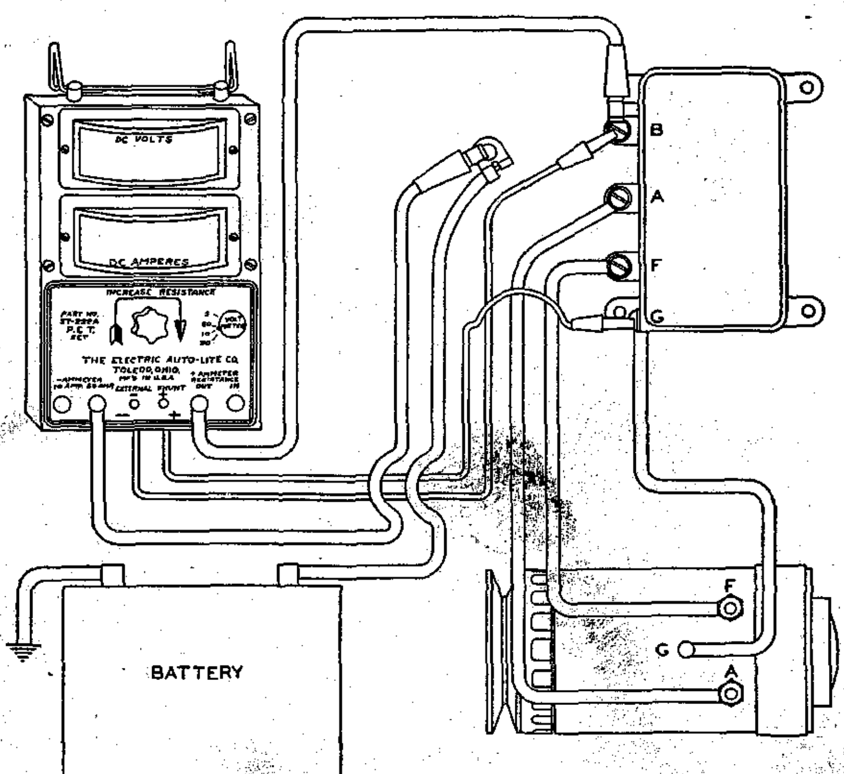


FIGURE 84

RELAYS AND REGULATORS — Continued

which the circuit breaker closes than the voltage at which the voltage regulator operates.

At the conclusion of this check it is necessary that a final flash test be made.

2. Check voltage regulator unit.

In making this test an accurate voltmeter must be used. It is to be connected to the regulator "B" terminal and to ground. See Figure 84.

To adjust its operation, increase or decrease the armature spring tension. Increasing the spring tension increases the voltage at which the unit will operate, while decreasing the tension decreases its operating voltage. This is done by adjusting the screw "B" Figure 83 which holds the lower end of the spring.

Replace the cover after making each adjustment. Take a flash voltage reading by stopping the generator and noting the maximum voltage reading when the generator is re-started.

3. Check current limiting regulator unit.

Connect the test ammeter in series between the regulator "B" terminal and the battery. See Figure 84.

By increasing the generator output with a lamp bank or other suitable resistance connected across the battery on the battery side of the ammeter, the ampere output should be as noted on the name plate of the regulator under test with an allowable variation of $\pm$ 5%.

Its operation is adjusted by varying the armature spring tension. This is done by turning the screw "C" Figure 83 which holds the lower end of the spring.

It is necessary that after all adjustments are made, a final flash test be made on all three units.

RELAYS AND REGULATORS — Continued

NUMERICAL LIST OF VR TYPE REGULATORS

See page 68 for test specifications.

Part No.	Rated Volts	Test Spec.	Ground Polarity	Carbon Resistors* R1	R2	R3	R4	Operating Amperage
VRA-4101A	12	1	Positive	135	15	.65	......	19-21
VRA-4102A	12	1	Positive	135	15	.65	......	39-41
VRA-4103A	12	2	Positive	135	15	.65	......	19-21
VRB-4002A	6	4†	Positive	60	......	......	......	29-31
VRB-4002C	6	4†	Positive	60	......	......	......	24-26
VRB-4002D	6	4†	Positive	60	......	......	......	27-29
VRB-4003A	6	4†	Positive	30	......	......	......	21-23
VRB-4004A	6	4†	Positive	60	11	......	......	29-31
VRB-4004B	6	4†	Positive	30	7	......	......	27-29
VRB-4004C	6	4†	Positive	60	......	......	......	24-26
VRB-4005A	6	4†	Positive	30	......	......	......	21-23
VRB-4006A	6	4†	Positive	30	......	......	......	11-13
VRB-4007A	6	4†	Negative	60	11	......	......	29-31
VRB-4007B	6	4	Negative	30	7	......	......	27-29
VRB-4008A	6	4†	Positive	60	11	......	......	29-31
VRB-4008AP	6	4†	Positive	60	11	......	......	29-31
VRB-4008B	6	4†	Positive	60	11	......	......	24-26
VRB-4008C	6	4	Positive	30	7	......	......	27-29
VRB-4008D	6	4	Positive	60	11	......	......	19-21
VRB-4008E	6	4	Positive	60	11	......	......	31-33
VRB-4009A	6	4†	Positive	60	11	......	......	24-26
VRB-4010A	6	4	Positive	30	7	......	......	27-29
VRB-4011A	6	4	Negative	60	11	......	......	24-26
VRB-4011B	6	4	Negative	30	7	......	......	27-29
VRB-4012A	6	4	Positive	30	7	......	......	27-29
VRB-4012A-1	6	4	Positive	30	7	......	......	27-29
VRB-4012B-1	6	4	Positive	38	7	......	......	34-36
VRC-4101A	6	5	Positive	80	5	.2	......	39-41
VRC-4101B	6	5	Positive	80	5	.2	......	49-51
VRC-4102A	6	5	Positive	80	5	.2	......	39-41
VRC-4102B	6	5	Positive	80	5	.2	......	29-31
VRD-4001A	6	4†	Positive	20	......	......	......	
VRD-4001B	6	4†	Positive	20	......	......	......	
VRD-4002A	6	4†	Positive	20	......	......	......	
VRD-4002B	6	4†	Positive	20	......	......	......	
VRD-4003A	6	6†	Positive	20	......	......	......	
VRD-4003B	6	6‡	Positive	20	......	......	......	
VRD-4004A	6	4†	Negative	20	......	......	......	
VRD-4006A	6	4†	Positive	20	......	......	......	
VRD-4006B	6	4	Positive	20	......	......	......	
VRD-4008A	6	8	Positive	20	......	......	......	
VRD-4008B	6	8	Positive	30	......	......	......	
VRD-4009A	6	4†	Positive	20	......	......	......	
VRD-4010A	6	4	Positive	20	......	......	......	
VRE-4001A	12	9	Positive	60	......	......	......	14-16
VRE-4001B	12	9	Positive	60	......	......	......	11-13
VRE-4001C	12	9	Positive	60	......	......	......	16-18
VRE-4002A	12	9	Positive	60	......	......	......	14-16
VRE-4002B	12	9	Positive	60	......	......	......	16-18
VRE-4002C	12	9	Positive	60	......	......	......	19-21
VRE-4002D	12	9	Positive	60	......	......	......	11-13
VRE-4003A	12	9	Positive	60	......	......	......	14-16
VRE-4003A-1	12	9	Positive	60	......	......	......	14-16
VRE-4004A	12	9	Positive	60	20	......	......	14-16
VRE-4005A	12	9	Positive	60	......	......	......	14-16

*Ohmic resistance is the marked value with a tolerance of ± 5%.

†Before serial number 8R-000001 set to test 3.

‡Before serial number 8R-000001 set to test 7.

RELAYS AND REGULATORS — Continued

Part No.	Rated Volts	Test Spec.	Ground Polarity	Carbon Resistors* R1	R2	R3	R4	Operating Amperage
VRF-4001A	12	9	Positive	30	......	......	......	....
VRF-4003A	12	9	Positive	30	......	......	......	....
VRF-4004A	12	9	Positive	30	......	......	......	....
VRF-4005A	12	9	Positive	30	......	......	......	....
VRF-4006A	12	9	Positive	30	......	......	......	....
VRF-4007A	12	9	Positive	30	......	......	......	....
VRG-4101A	12	2	Positive	135	15	.65	......	31-34
VRG-4102A	12	1	Positive	135	15	.65	......	31-34
VRG-4103A	12	1	Negative	135	15	.65	......	19-21
VRH-4101A	12	10	Positive	80	15	30	1	54-56
VRH-4101B	12	10	Positive	80	15	30	1	49-51
VRH-4102A	12	10	Negative	80	15	30	1	54-56
VRH-4104A-1	12	10	Negative	80	15	30	1	54-56
VRJ-4001A	6	4	Positive	60	11	......	......	39-41
VRJ-4002A	6	4	Negative	60	11	......	......	39-41
VRK-4001A	24	11	Positive	160	200	......	......	9.9-10.1
VRO-4001A	12	9	Positive	60	20	......	......	29-31
VRP-4001A	6	12	Positive	38	7	......	......	34-36
VRP-4001B	6	12	Positive	60	15§	......	......	31-33
VRP-4001C	6	12	Positive	30	7	......	......	27-29
VRP-4001D	6	12	Positive	60	11	......	......	29-31
VRP-4001E	6	12	Positive	60	11	......	......	24-26
VRP-4001F	6	12	Positive	60	15§	......	......	39-41
VRP-4002A	6	12	Positive	38	7	......	......	34-36
VRP-4002B	6	12	Positive	30	7	......	......	27-29
VRP-4002C	6	12	Positive	38	7	......	......	34-36
VRP-4002D	6	12	Positive	60	15	......	......	34-36
VRP-4003A	6	12	Positive	38	7	......	......	34-36
VRP-4004A	6	12	Positive	38	7	......	......	34-36
VRP-4004B	6	12	Positive	60	11	......	......	29-31
VRP-4004C	6	12	Positive	60	15§	......	......	31-33
VRP-4004D	6	12	Positive	30	7	......	......	27-29
VRP-4004E	6	12	Positive	60	15§	......	......	39-41
VRP-4004F	6	12	Positive	38	7	......	......	34-36
VRP-4004F-1	6	12	Positive	38	7	......	......	34-36
VRP-4004G	6	12	Positive	38	7	......	......	24-26
VRP-4004H	6	12	Positive	38	7	......	......	29-31
VRP-4005A	6	12	Negative	38	7	......	......	34-36
VRP-4005B	6	12	Negative	60	15§	......	......	31-33
VRP-4005C	6	12	Negative	60	11	......	......	24-26
VRP-4005D	6	12	Negative	30	7	......	......	27-29
VRP-4005E	6	12	Negative	60	15	......	......	39-41
VRP-4006A	6	12	Positive	60	11	......	......	29-31
VRP-4006AP	6	12	Positive	60	11	......	......	29-31
VRP-4006B	6	12	Positive	60	11	......	......	24-26
VRP-4006C	6	12	Positive	30	7	......	......	27-29
VRP-4006D	6	12	Positive	20	7	......	......	29-31
VRP-4006E	6	12	Positive	60	15§	......	......	31-33
VRP-4006F	6	12	Positive	60	15§	......	......	39-41
VRP-4006G	6	12	Positive	30	7	......	......	24-26
VRP-4007A	6	12	Negative	60	15§	......	......	31-33
VRP-4007B	6	12	Negative	60	15§	......	......	39-41
VRP-4007C	6	12	Negative	38	7	......	......	34-36
VRP-4007D	6	12	Negative	38	7	......	......	29-31
VRP-4008A	6	13	Positive	60	15§	......	......	39-41
VRP-4008B	6	13	Positive	38	11	......	......	34-36
VRP-4008C	6	13	Positive	60	15§	......	......	31-33
VRP-4008D	6	13	Positive	60	15	......	......	34-36
VRP-4009A	6	12	Negative	60	11	......	......	29-31

*Ohmic resistance is the marked value with a tolerance of ± 5%.

§Before serial 6U-000001 R2 was marked 11.

RELAYS AND REGULATORS — Continued

Part No.	Rated Volts	Test Spec.	Ground Polarity	Carbon Resistors* R1	R2	R3	R4	Operating Amperage
VRP-4009B	6	12	Negative	30	7	......	......	27-29
VRP-4009C	6	12	Negative	60	15§	......	......	39-41
VRP-4009D	6	12	Negative	30	7	......	......	24-26
VRP-4010A	6	12	Positive	60	15	......	......	31-33
VRP-4101A	6	12	Positive	30	......	......	......	21-23
VRP-4102A	6	12	Positive	30	......	......	......	21-23
VRP-4103A	6	12	Positive	60	11	......	......	19-21
VRP-4104A	6	12	Negative	60	11	......	......	19-21
VRP-4104B	6	12	Negative	60	30	......	......	19-21
VRP-4105A	6	12	Positive	60	30	......	......	19-21
VRP-4201A-1	6	14	Positive	38	7	......	......	34-36
VRP-4202A-1	6	14	Positive	38	7	......	......	34-36
VRR-4001A	6	13	Positive	30	......	......	......	......
VRR-4001B	6	13	Positive	20	......	......	......	......
VRR-4002A	6	12	Positive	30	......	......	......	......
VRR-4002B	6	12	Positive	20	......	......	......	......
VRR-4003A	6	12	Positive	20	......	......	......	......
VRR-4004A	6	12	Negative	20	......	......	......	......
VRR-4004B	6	12	Negative	30	......	......	......	......
VRR-4005A	6	12	Positive	20	......	......	......	......
VRS-4001A	12	15	Positive	60	30	......	......	14-16
VRS-4001B	12	15	Positive	60	30	......	......	17-19
VRS-4002A	12	15	Positive	60	30	......	......	14-16
VRS-4003A	12	15	Positive	60	30	......	......	14-16
VRS-4004A	12	15	Positive	60	30	......	......	14-16
VRS-4004B	12	15	Positive	60	30	......	......	16-18
VRS-4004C	12	15	Positive	80	30	......	......	16-18
VRS-4005A	12	15	Positive	60	......	......	......	14-16
VRS-4005B	12	15	Positive	60	......	......	......	16-18
VRS-4005C	12	15	Positive	60	......	......	......	19-21
VRS-4005D	12	15	Positive	60	......	......	......	11-13
VRS-4005E	12	15	Positive	80	......	......	......	9-11
VRS-4006A	12	15	Positive	60	......	......	......	14-16
VRS-4006B	12	15	Positive	60	......	......	......	11-13
VRS-4006C	12	15	Positive	60	......	......	......	16-18
VRS-4007A	12	15	Positive	60	......	......	......	14-16
VRS-4007A-1	12	15	Positive	60	......	......	......	14-16
VRS-4007B	12	15	Positive	60	......	......	......	9-11
VRS-4008A	12	15	Negative	60	......	......	......	14-16
VRS-4009A	12	15	Negative	60	30	......	......	16-18
VRT-4001A	12	15	Positive	30	......	......	......	
VRT-4002A	12	15	Positive	30	......	......	......	
VRT-4002A-1	12	15	Positive	30	......	......	......	
VRT-4003A-1	12	15	Positive	30	......	......	......	
VRT-4004A	12	15	Positive	60	......	......	......	
VRU-4001A	12	15	Positive	30	20	......	......	7-9
VRU-4002A	12	15	Positive	30	20	......	......	7-9
VRV-4001A	24	16	Positive	160	200	......	......	9.8-10.2
VRV-4002A	24	16	Positive	160	200	......	......	9.8-10.2
VRW-4001A	6	12	Positive	30	......	......	......	11-13
VRW-4002A	6	12	Positive	30	......	......	......	13-15
VRW-4003A	6	12	Negative	30	......	......	......	15-17
VRW-4004A	6	12	Positive	60	30	......	......	15-17
VRX-4001A	12	15	Positive	80	20	......	......	29-31
VRX-4002A	12	15	Negative	80	20	......	......	29-31
VRY-4201A	6	17	Positive	80	7	80	......	25-27
VRY-4202A	6	17	Positive	80	7	80	......	25-27
VRZ-4101A	12	18	Positive	245	11	38	......	15-16

*Ohmic resistance is the marked value with a tolerance of ± 5%.

§Before serial 6U-000001 R2 was marked 11.

RELAYS AND REGULATORS — Continued

VR REGULATOR TEST SPECIFICATIONS

TEST	1	2	3	4
CIRCUIT BREAKER				
Res. of Voltage Winding	49.7	49.7	35-39	35-39
Armature Air Gap‡	.055"-.062"	.055"-.062"	.034"-.038"	.034"-.038"
Contact Point Gap	.015" min.	.015" min.	.015" min.	.015" min.
Points Close (Volts)	13.0-13.5	13.0-13.5	6.4-7.0	6.4-7.0
Points Open (Amps.)	.5-4.0	.5-4.0	.5-3.0	.5-3.0
VOLTAGE REGULATOR				
Res. of Winding	15.7-17.3	15.7-17.3	12.8-14.3	10.4-11.2
Armature Air Gap	.040"-.042"	.040"-.042"	.0595"-.0625"	.0595"-.0625"
Contact Point Gap	.010" min.	.010" min.	.010"-.020"	.010"-.020"
Operating Voltage				
50°F	14.51	14.31	7.68	7.51
60°F	14.48	14.28	7.66	7.48
70°F	14.45	14.25	7.65	7.45
80°F	14.42	14.22	7.63	7.42
90°F	14.39	14.19	7.62	7.39
100°F	14.36	14.16	7.61	7.36
110°F	14.33	14.13	7.60	7.33
120°F	14.30	14.10	7.59	7.30
Tolerance	± .15	± .15	± .15	± .15
CURRENT REGULATOR				
Res. of Frequency Winding	.018	.018		
Armature Air Gap	.047"-.049"	.047"-.049"	.0595"-.0625"	.0595"-.0625"
Contact Point Gap	.010" min.	.010" min.	.010"-.020"	.010"-.020"

TEST	5	6	7	8
CIRCUIT BREAKER				
Res. of Voltage Winding	15.8-17.4	35-39	35-39	35-39
Armature Air Gap‡	.055"-.062"	.034"-.038"	.034"-.038"	.034"-.038"
Contact Point Gap	.015" min.	.015" min.	.015" min.	.015" min.
Points Close (Volts)	6.5-7.0	6.4-7.0	6.4-7.0	6.4-7.0
Points Open (Amps.)	.5-4.0	.5-3.0	.5-3.0	1.5-4.5
VOLTAGE REGULATOR				
Res. of Winding	4.3-4.7	10.4-11.2	12.8-14.3	10.4-11.2
Armature Air Gap	.040"-.042"	.0595"-.0625"	.0595"-.0625"	.0595"-.0625"
Contact Point Gap	.010" min.	.010"-.020"	.010"-.020"	.010"-.020"
Operating Voltage				
50°F	7.51	7.63	7.98	7.63
60°F	7.48	7.56	7.96	7.56
70°F	7.45	7.50	7.95	7.50
80°F	7.42	7.43	7.93	7.43
90°F	7.39	7.37	7.92	7.37
100°F	7.36	7.30	7.91	7.30
110°F	7.33	7.24	7.89	7.24
120°F	7.30	7.17	7.88	7.17
Tolerance	± .15	± .15	± .15	± .15
CURRENT REGULATOR				
Res. of Frequency Winding	.066			
Armature Air Gap	.047"-.049"			
Contact Point Gap	.010" min.			

‡With points open.

RELAYS AND REGULATORS — Continued

TEST	9	10	11	12
CIRCUIT BREAKER				
Res. of Voltage Winding	111-123	49.7	345	29.8-33.0
Armature Air Gap‡	.034"-.038"	.060"-.065"	.034"-.038"	.031"-.034"
Contact Point Gap	.015" min.	.015" min.	.015" min.	.015" min.
Points Close (Volts)	13.0-13.75	13.0-13.5	25.0-25.75	6.4-6.6
Points Open (Amps.)	.5-3.0	.5-4.0	.5-2.0	
Points Open (Volts)				4.8-5.6
VOLTAGE REGULATOR				
Res. of Winding	45.8-49.6	15.7-17.3	191-209	10.8-12.0
Armature Air Gap	.0595"-.0625"	.040"-.042"	.0595"-.0625"	.048"-.052"
Contact Point Gap	.010"-.020"	.010" min.	.010"-.020"	.012" min.
Operating Voltage				
50°F	14.59	14.51	27.84	7.41
60°F	14.54	14.48	27.67	7.38
70°F	14.50	14.45	27.50	7.35
80°F	14.46	14.42	27.33	7.32
90°F	14.42	14.39	27.16	7.29
100°F	14.37	14.36	26.99	7.27
110°F	14.33	14.33	26.82	7.24
120°F	14.28	14.30	26.65	7.21
Tolerance	± .15	± .15	± .10	± .15
CURRENT REGULATOR				
Res. of Frequency Winding				
Armature Air Gap	.0595"-.0625"	.047"-.049"	.0595"-.0625"	.048"-.052"†
Contact Point Gap	.010"-.020"	.010" min.	.010"-.020"	.012" min.

TEST	13	14	15	16
CIRCUIT BREAKER				
Res. of Voltage Winding	29.8-33.0	29.8-33.0	111-125	267-297
Armature Air Gap‡	.031"-.034"	.031"-.034"	.031"-.034"	.048"-.052"
Contact Point Gap	.015" min.	.015" min.	.015" min.	.015" min.
Points Close (Volts)	6.4-6.6	6.4-6.6	13.0-13.75	26.0-27.0
Points Open (Amps.)				1.9-3.0
Points Open (Volts)	4.8-5.6	4.8-5.6	9.6-10.8	
VOLTAGE REGULATOR				
Res. of Winding	10.8-12.0	10.8-12.0	43.7-49.3	179-201
Armature Air Gap	.048"-.052"	.048"-.052"	.048"-.052"	.048"-.052"
Contact Point Gap	.012" min.	.012" min.	.012" min.	.012" min.
Operating Voltage				
50°F	7.63	7.44	14.59	28.84
60°F	7.57	7.39	14.54	28.67
70°F	7.50	7.35	14.50	28.50
80°F	7.43	7.31	14.46	28.32
90°F	7.38	7.27	14.42	28.15
100°F	7.31	7.22	14.37	27.98
110°F	7.24	7.18	14.33	27.81
120°F	7.17	7.14	14.29	27.64
Tolerance	± .15	± .15	± .30	± .50
CURRENT REGULATOR				
Res. of Frequency Winding				
Armature Air Gap	.048"-.052"†	.034"-.038"	.048"-.052"§	.034"-.038"
Contact Point Gap	.012" min.	.012" min.	.012" min.	.012" min.

‡With points open.

†Before serial 5U-000001 the air gap was .034"-.038".
§Before serial 12T-000001 the air gap with .034"-.038".

RELAYS AND REGULATORS — Continued

TEST	17	18
CIRCUIT BREAKER		
Res. of Voltage Winding	15.8-17.4	49.7
Armature Air Gap‡	.0595"-.0625"	.060"-.065"
Contact Point Gap	.015" min.	.015" min.
Points Close (Volts)	6.5-6.6	13.0-13.5
Points Open (Amps.)	0.5-4.0	0.5-4.0
VOLTAGE REGULATOR		
Res. of Winding	4.3-4.7	15.7-17.3
Armature Air Gap	.040"-.042"	.0465"-.0495"
Contact Point Gap	.010" min.	.010" min.
Operating Voltage		
50°F	7.41	14.31
60°F	7.38	14.28
70°F	7.35	14.25
80°F	7.32	14.22
90°F	7.29	14.19
100°F	7.26	14.16
110°F	7.23	14.13
120°F	7.20	14.10
Tolerance	± .15	± .15
CURRENT REGULATOR		
Res. of Frequency Winding	.033-.037	
Armature Air Gap	.047"-.049"	.0465"-.0495"
Contact Point Gap	.010" min.	.010" min.

‡With points open.

STARTING MOTORS AND SWITCHES

DESCRIPTION AND FUNCTION

The starting motor is designed to crank the engine when the starting switch closes the circuit between the storage battery and the motor. The design of the starting motor depends upon the type and application of the engine on which it is to be used. Starting motors vary as to size, number of poles and number of brushes.

MOTOR DRIVES

To transmit power to the flywheel of the engine Auto-Lite starting motors use either an overrunning clutch or a Bendix drive. Some motors have a gear reduction between the armature and drive pinion to increase the power for heavy duty installations. (See Figure 85).

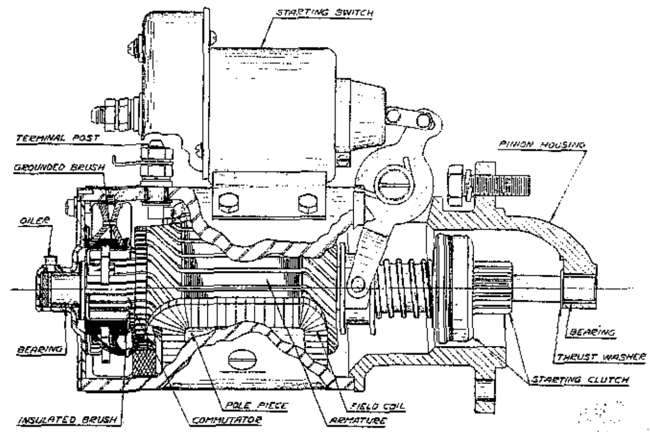


FIGURE 87

In either case the action of the clutch is identical. Figure 88 illustrates a typical overrunning clutch. The clutch has internal splines to match the splines on the armature shaft. When the yoke lever is shifted, either mechanically or electrically, the complete drive is moved along the armature shaft

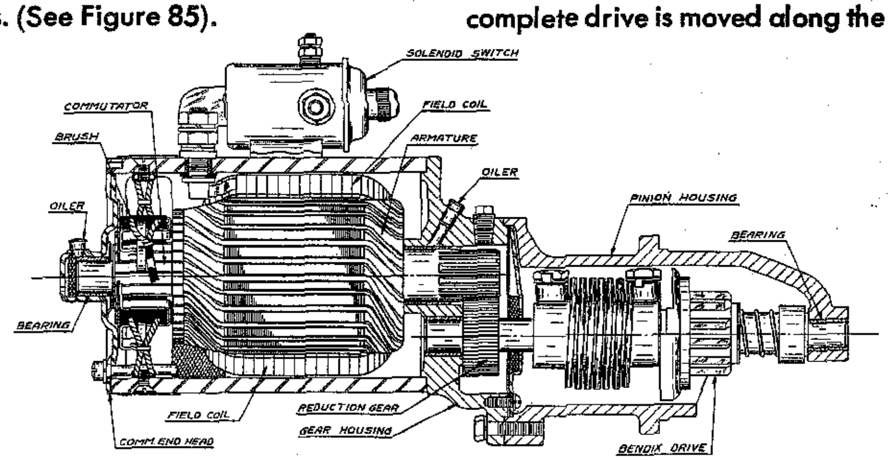


FIGURE 85

The overrunning clutch pinion may be shifted either mechanically through a starter pedal (Figure 86) or electrically by a solenoid (Figure 87).

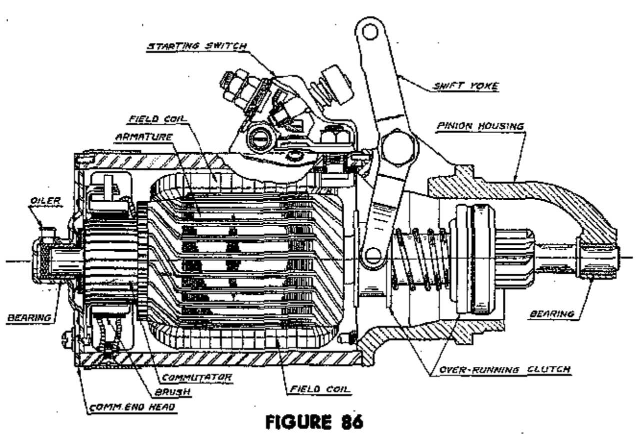


FIGURE 86

until the pinion meshes with the flywheel ring gear. If the pinion teeth do not mesh with the flywheel teeth the movement of the yoke arm is taken up by the spring. When the switch contacts close the armature rotates allowing the spring to

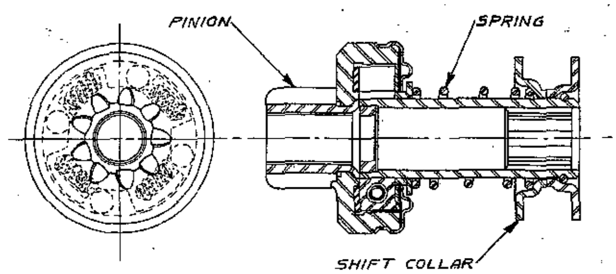


FIGURE 88

STARTING MOTORS AND SWITCHES — Continued

complete the meshing action and crank the engine. As soon as the engine starts the flywheel drives the pinion faster than the starting motor armature bringing the clutch into action and preventing the engine from driving the armature at excessive speeds.

The Bendix drive is illustrated in Figure 89. It

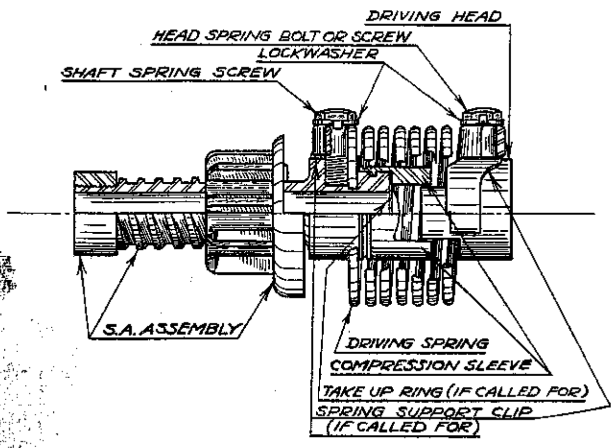


FIGURE 89

consists of a threaded sleeve fastened to the armature shaft through a drive spring and a pinion mounted on the threads of the sleeve. When the starting circuit is closed the armature revolves turning the sleeve within the pinion forcing the gear forward meshing it with the flywheel gear. The sudden shock of meshing is absorbed by the spring. When the engine starts the pinion is driven faster than the sleeve and is forced back along the threads automatically de-meshing it from the flywheel.

STARTING SWITCHES

Starting switches, which control the closing and opening of the circuit between the storage battery and the motor, may be of either the manual or solenoid type.

Manual type starting switches may be one of four types. The type illustrated in Figure 90 is used with starting motors having a Bendix drive

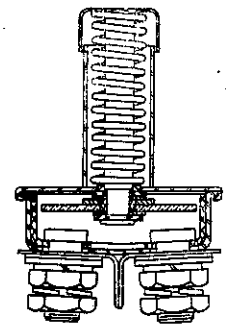


FIGURE 90

and is mounted separate from the motor. It has a set of contacts that are opened and closed by mechanical action. The contacts are designed for the large currents in a starting circuit. Spring action is used to open the contacts to give a clean break and to minimize arcing.

The second type of manual switch is shown in Figure 91 and is remote controlled from the dash

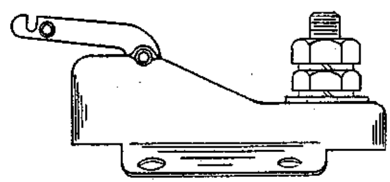


FIGURE 91

by a Bowden wire. This type is also used on starting motors using a Bendix drive.

The third type such as shown in Figure 92 is mechanically closed by depressing the clutch

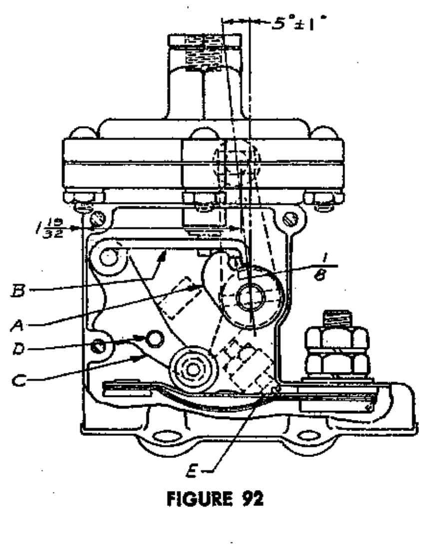


FIGURE 92

STARTING MOTORS AND SWITCHES — Continued

pedal and has a vacuum release and vacuum release lock to prevent operation of the starting motor when the clutch pedal is depressed while the engine is running. With the engine not running depressing the clutch pedal closes the startig switch thru cam "A," latch "B" and pressure arm "C." When the engine starts the latch "B" is lifted thru a connection to the vacuum diaphragm so that it disengages with the cam and the switch is opened by spring action. As long as the engine continues to run the latch is held in the disengaged position so that the clutch pedal can be operated without closing the switch.

The last type such as shown mounted on the motor illustrated in Figure 86 is used only on motors with overrunning clutches. It is controlled by a foot pedal that is connected by linkage to the shift yoke which moves the clutch pinion into mesh and then closes the switch contacts.

Solenoid starting switches may be divided into two types: those which magnetically close the starting circuit and those which not only close the starting circuit but also shift the overrunning clutch pinion.

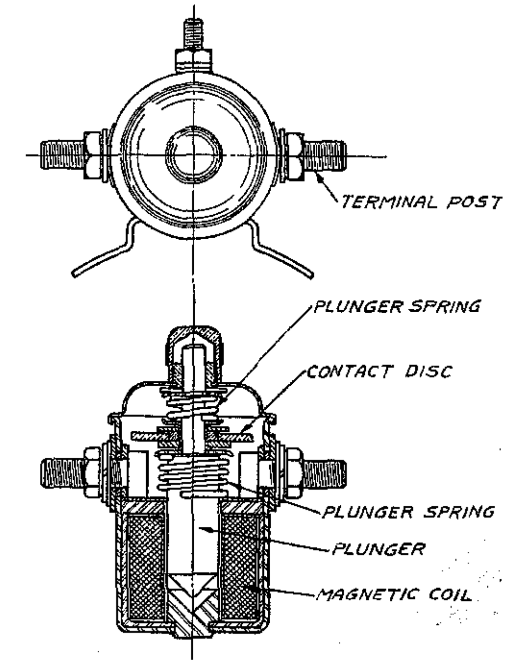


FIGURE 93

The first of these types is shown in Figure 93 and is used with Bendix drive motors. It magnetically closes the circuit between the storage battery and the motor and is controlled by a push button located on the instrument panel.

The second type not only magnetically closes the starting circuit but it also shifts the overrunning clutch pinion into mesh with the flywheel

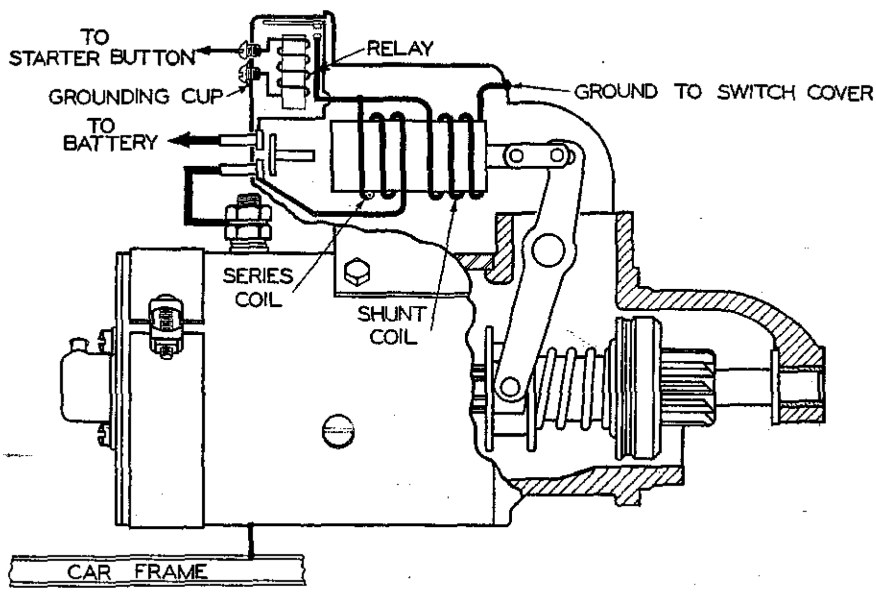


FIGURE 94

STARTING MOTORS AND SWITCHES — Continued

gear. It is controlled by a push button, mounted on the instrument panel, thru a relay mounted within the switch. (See Figure 94).

The solenoid coil includes two windings; a series winding connected from the relay stationary contact to the main switch terminal connecting with the starter motor and a shunt winding connected from the relay stationary contact to ground. Between the time the relay contacts close and the main switch is closed both windings have current flowing thru them causing the solenoid to exert its strongest magnetic pull on the plunger thus assuring positive meshing of the pinion. When the main switch contacts close the series winding is short circuited and the plunger is held in place by the shunt winding only. This results in a minimum amount of arcing at the relay contacts when the switch opens.

MAINTENANCE PROCEDURE

A periodic inspection should be made of the starting circuit. While the interval between these checks will vary accordng to the type of service it should, under normal conditions, be made every 5000 miles. At this check the following points should be inspected.

1. Wiring

A visual inspection should be made of all wires to be sure that none are broken and that all connections are clean and tight.

2. Commutator

If the commutator is dirty or discolored it can be cleaned with 00 sandpaper. Blow the sand out of the motor after cleaning.

Should the commutator be rough or worn the motor should be removed from the egine for cleaning and reconditioning. Instructions for the servicing of starting motors are given later in this section.

3. Brushes

The brushes should slide or swing freely in their holders and make full contact on the commutator. Worn brushes should be replaced.

4. Lubrication

Motors having oilers should have 5 to 10 drops of a good grade of S.A.E. No. 20 oil added each 5000 miles.

STARTING MOTOR OVERHAUL

At intervals of approximately 25,000 miles the starting motor circuit should be thoroughly checked and the motor removed from the car for cleaning and checking.

1. Starting Circuit

The starting circuit should be inspected to be sure all connections are clean and tight and that the insulation on the wires is not worn or damaged. The starting circuit should be given a voltage loss test to make sure there is no loss of starting motor efficiency due to high resistance connections. (See Figure 95) In making this check the voltage loss from the battery terminal to the starting motor terminal should not exceed .12 volts maximum for each 100 amperes. The loss in voltage between the battery ground post and the starting motor frame should not exceed .12 volts maximum for each 100 amperes. If the voltage loss is greater than the above limits the voltage should be measured over each part of the circuit to locate the resistance causing voltage loss. When measuring the voltage loss across solenoid

STARTING MOTORS AND SWITCHES — Continued

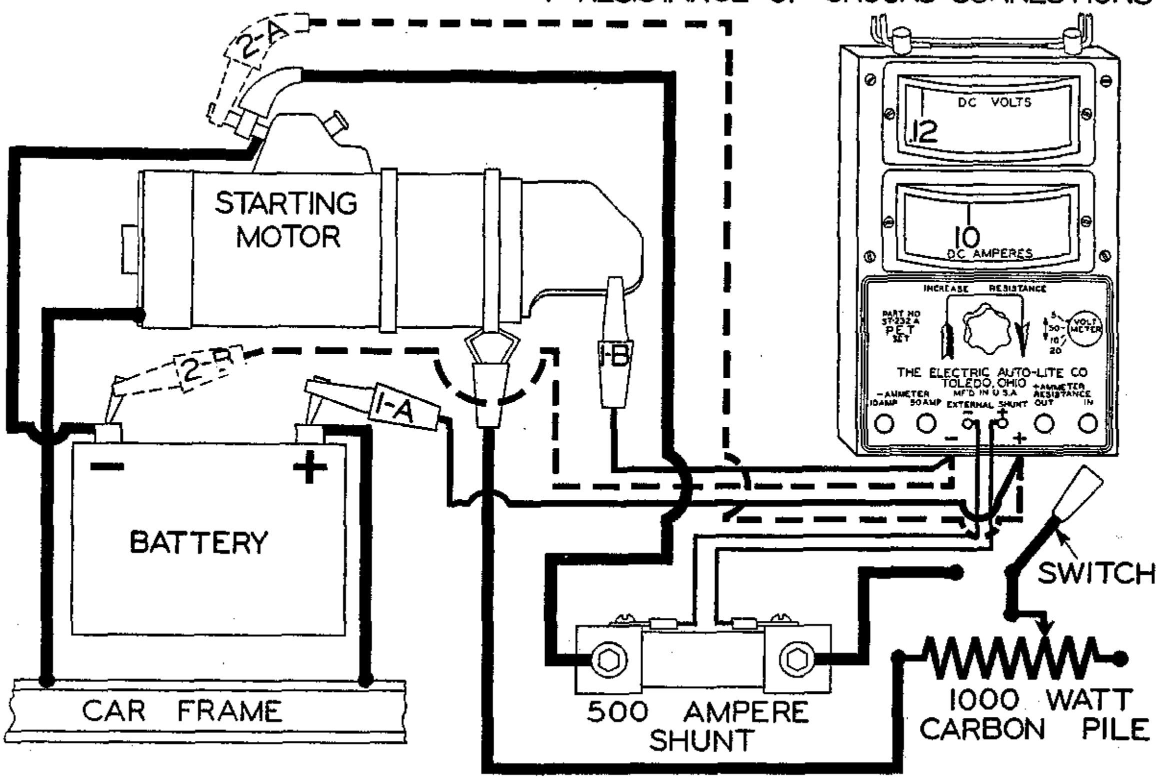


FIGURE 95

switches the contacts should be closed electrically to simulate actual conditions of operation.

DISASSEMBLY

To remove the starting motor from the car disconnect the leads and cover the battery lead with a short piece of hose to prevent short circuiting. Take out the flange bolts holding the motor to the flywheel housing. The motor will then lift off and can be taken to the bench for a complete overhaul.

When disassembling the motor each part should be removed and cleaned and inspected for wear or damage. The Bendix drive or overrunning clutch should be cleaned and inspected for wear and for a distorted spring. Bearings should be checked for proper clearance and fit. All insulation should be free from oil and in good condition. The armature, field coils and brushes should be checked for grounds or open circuits.

2. Brushes

The brushes should slide or swing freely in their holders and make full contact on the commutator. Worn brushes should be replaced.

When replacing brushes that have the lead riveted to the brush holder the rivet should be removed and the new rivet should be securely staked to make sure the brush holder is solid and that the lead makes a good ground contact. Brushes that are soldered to the field coil lead should be unsoldered and have the loop in the field coil lead opened. The new brush pigtail should be inserted to its full depth in the loop and then clinched before resoldering. A good soldering job must be done to insure no loss of starting motor efficiency due to a poor contact.

STARTING MOTORS AND SWITCHES — Continued

Brush spring tension should be checked with a spring scale. See specifications on page 81. To check the tension on swinging type brushes hook the scale under the brush screw tight against the brush and exert the pull in a line parallel to the side of the brush. Take the reading just as the brush leaves the commutator. When checking the tension of reaction type brush springs hook the scale under the brush spring near the brush and pull on a line parallel with the side of the brush. Take the reading just as the spring leaves the brush.

If the brush spring tension is too low there will be a loss of efficiency due to poor brush contact. If the tension is too great the commutator and brushes will wear excessively and have short life. It is therefore important that the brush spring tension be kept within the limits specified. To change reaction type spring tension twist the spring holder with long nosed pliers. On swinging type brush holders it is necessary to remove the spring and arm, and bend the spring to change the tension.

3. Commutator

Check the commutator for wear or discoloration. If the commutator is only slightly dirty or discolored it can be cleaned with 00 or 000 sandpaper. Blow the sand out of the motor after cleaning the commutator. If the commutator is rough or worn the armature should be removed and the commutator turned down in a lathe.

4. Armature

The armature should be visually inspected for mechanical defects before being checked for shorted or grounded coils.

For testing armature circuits it is advisable to use a set of test probes such as illustrated in Figure 96.

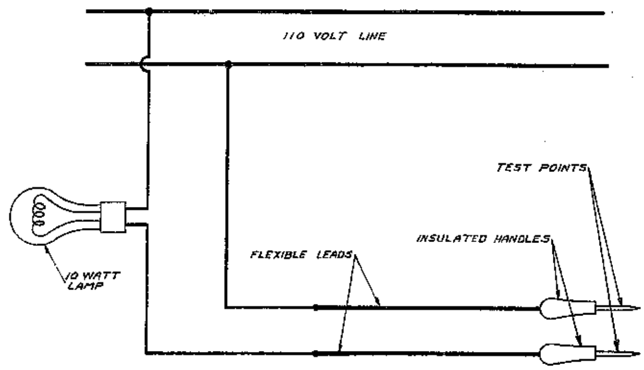
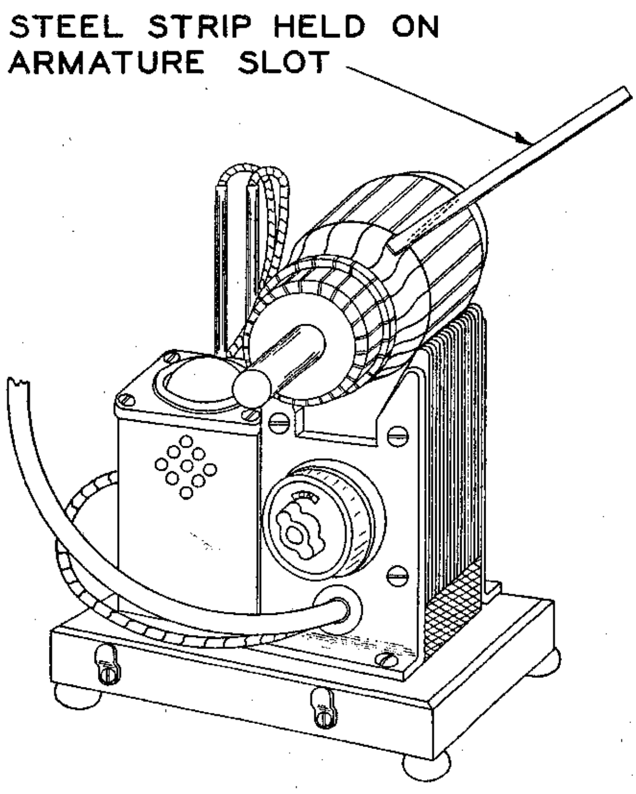


FIGURE 96

'o test the armature for grounds touch one point to a commutator segment and touch the core or shaft with the other probe. Do not touch the points to the bearing surface or to the brush surface as the arc formed will burn the smooth finish. If the lamp lights, the coil connected to the commutator segment is grounded.

To test for shorted armature coils a growler is necessary. The armature is placed against the



STARTING MOTORS AND SWITCHES — Continued

core and a steel strip held on the armature. The armature is then rotated slowly by hand. If a shorted coil is present the steel strip will become magnetized and vibrate. This test is illustrated in Figure 97.

5. Field Coils

Using the test probes illustrated in Figure 96 check the field coils for both opens and grounds. To test for grounds place one probe on the motor frame or pole piece and touch the other probe to the field coil terminals. If a ground is present the lamp will light.

To test for open circuits place the probes on the field coil terminals across each coil separately. If the light does not light the coil is open circuited.

6. Brush Holder Inspection

Using the test probes illustrated in Figure 96 touch the insulated brush holder with one probe and a convenient ground on the C.E. plate with the other probe. If the lamp lights it indicates a grounded brush holder.

7. Assembly of Motor

When assembling absorbent bronze bearings always use the proper arbor as these arbors are designed to give the proper bearing fit. Soak the bearing in oil before assembling in the bearing bore.

The pinion end of the armature shaft should be given a light wipe with very light oil when assembling.

Brushes should be correctly installed and connected as previously outlined in order to be sure of proper starting motor efficiency. Proper brush seating should be insured by sanding the brushes to fit the commutator. To sand the brushes wrap a strip of 00 sandpaper around the commutator and turn the armature slowly in the direction of rotation. Blow the sand and carbon dust out of the motor after sanding.

When installing the yoke and overrunning clutch the yoke shoes should be assembled with the radial side toward the pinion end of the clutch.

8. Lubrication

Auto-Lite starting motors are equipped with absorbent bronze bearings. These bearings are able to absorb 25% of their own volume in oil.

Most of the drive end and intermediate bearings do not need any attention. The commutator end bearing and some of the intermediate bearings are equipped with oilers which should be given 5 to 10 drops of medium engine oil every 5000 miles. Do not over lubricate as excessive lubrication will damage commutators and insulation.

Gear reduction motors have a grease pocket in the gear chamber which should be filled with a high melting point grease when assembling. If this gear reduction is provided with a grease cup it should be given one turn every 5000 miles. If an oiler is provided it should be given 5 to 10 drops of medium engine oil every 5000 miles.

When the starting motor is serviced the bearings should be soaked in oil and the bearing seats should be given a light wipe of oil.

9. Bench Test

The motor should first be checked to see that the free running voltage and current are within specifications. (See page 81 for test data.) To test connect the motor to a battery and voltmeter as in Figure 98. If the current is too high check the bearing alignment and end play to make sure there is no binding or interference.

STARTING MOTORS AND SWITCHES — Continued

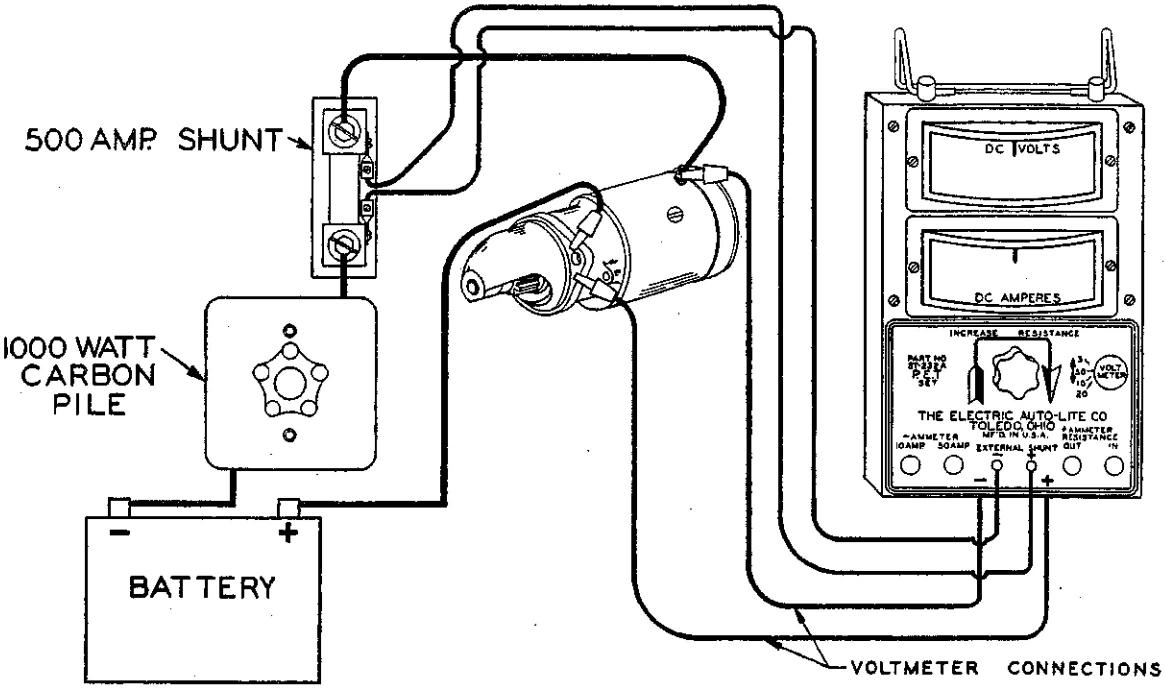


FIGURE 98

Using a spring scale and torque arm as shown in Figure 99 check the stall torque to see that the motor is producing its rated cranking power. The stall torque will be the product of the spring scale reading and the length of the arm in feet. If the torque is not up to specifications check the seating of the brushes on the commutator and the internal connection of the motor for high resistance. (See page 81 for test data.)

The Bendix or clutch should be checked for correct operation. The Bendix pinion should be checked to see that it shifts when the motor is operated under no load. The overrunning clutch should be inspected for proper clearance when in the free running position. This clearance should be 5/64" ±1/64" between the outer edge of the pinion and the thrust washer next to the outer pinion housing bearing as shown in Figure 100.

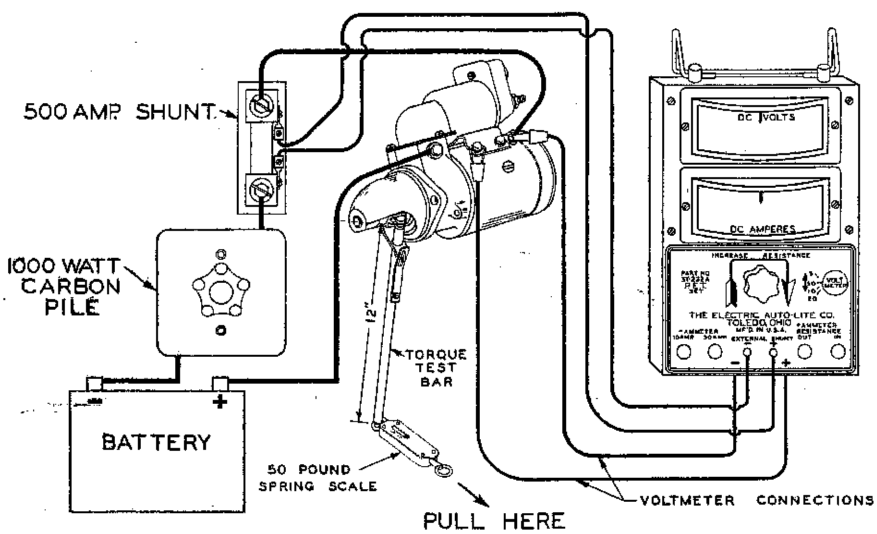


FIGURE 99

STARTING MOTORS AND SWITCHES — Continued

To check this clearance shift the pinion by applying pressure to the yoke arm on the positive shift type or by applying pressure to the plunger of the solenoid switch on the magnetic gear shift type.

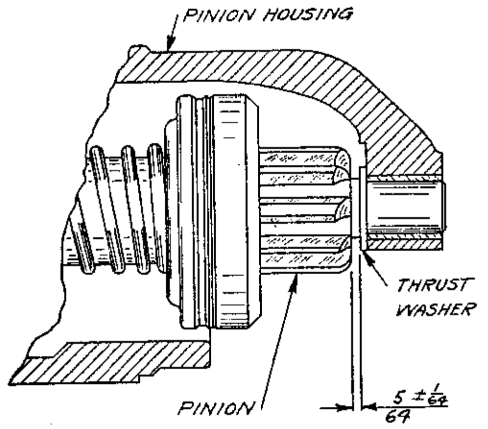


FIGURE 100

To adjust the clearance, screw the starting switch plunger in or out on the positive shift starting motors or adjust the plunger screw on the magnetic shift starting motors.

STARTING SWITCH TESTS

MANUAL SWITCHES

This type of switch can best be tested by comparing voltage readings between the terminal connected to the battery and the terminal connected to the starting motor. A maximum variation not in excess of .05 volts per 100 amperes is allowed. A greater variation indicates poor switch contacts. Switch contacts should be filed for full surface contact or the complete switch replaced.

SS-4000 SERIES SWITCHES

This type switch should be checked to see that the opening and closing voltages are within limits and that the voltage loss across the main contacts is not in excess of .05 volts per 100 amperes. When checking this voltage loss have the contacts closed by energizing the switch to approximate the actual conditions of operation.

TEST SPECIFICATIONS

Amperes Draw

- 6 volt units—2.9 to 3.3 amperes at 6 volts.
- 12 volt units—1.47 to 1.57 amperes at 12 volts.

Switch Contacts Close

- 6 volt units—4 to 5 volts
- 12 volt units—8 volts maximum

Switch Contacts Open

- 6 volt units—.5 to 2.0 volts
- 12 volt units—1.5 to 4.0 volts

SS-4100, SS-4200 and SS-4700 SWITCHES

The relay contacts when open should have .025 inch minimum to .035 inch maximum gap.

Before making any tests on the switch make sure that all linkage operates freely with no binding and that the switch plunger can be bottomed in the solenoid without drag or restriction. When under test the plunger should bottom instantly without chattering.

TEST SPECIFICATIONS

SS-4100—6 volt units

Relay

- Contacts close 3.5 to 4.5 volts
- Contacts open 1.5 to 2.5 volts

Solenoid

- Shunt coil only 14 to 16 amperes at 6.0 volts
- Shunt and series 34 to 38 amperes at 3.0 volts

SS-4100—12 volt units

Relay

- Contacts close 7.0 to 9.0 volts
- Contacts open 3.0 to 5.0 volts

Solenoid

- Shunt coil only 5.0 to 6.0 amperes at 12.0 volts
- Shunt and series 22.0 to 26.0 amperes at 6.0 volts

STARTING MOTORS AND SWITCHES — Continued

SS-4200—6 volt units

Relay

Contacts close 3.5 to 4.5 volts

Contacts open 1.5 to 2.5 volts

Solenoid

Shunt coil only 7.0 to 8.0 amperes at 3.0 volts

Series coil only 27.0 to 30.0 amperes at 3.0 volts

SS-4200—12 volt units

Relay

Contacts close 7.0 to 9.0 volts

Contacts open 3.0 to 5.0 volts

Solenoid

Shunt coil only 1.8 to 2.2 amperes at 5.0 volts

Series coil only 15.5 to 18.5 amperes at 5.0 volts

SS-4700—6 volt units

Relay

Contacts close 3.5 to 4.5 volts

Contacts open 1.5 to 2.5 volts

Solenoid

Shunt coil only 7.0 to 8.0 amperes at 3.0 volts

Series coil only 38.0 to 42.0 amperes at 3.0 volts

STARTING MOTORS AND SWITCHES — Continued

STARTING MOTOR TEST SPECIFICATIONS

Type	Volts	Gear Ratio	Spring Tension Ounces	No Load Volts	No Load Amps.	No Load Min. RPM	Stall Test Volts	Stall Test Amps.	Stall Test Min. Ft. Lbs.
DI	6	....	56-60	6.0	60	4500	3.6	730	29.2
DI	12	....	56-60	......	....	....	6.0	410	16.6
DN	6	....	56-60	6.0	50	3000	3.6	810	39.0
DY	6	....	36-40	6.0	50	3000	3.5	720	29.4
MAB	6	....	42-53	5.5	60	3700	4.0	775	22.5
MAD	6	....	42-53	5.5	60	3600	4.0	730	18.5
MAJ	6	....	42-53	5.5	67	4100	4.0	750	17.0
MAK	6	....	38-61	5.5	70	5000	4.0	520	7.0
MAL	6	....	42-53	5.5	50	3200	4.0	825	32.0
MAO	6	....	24-32	5.5	44	2700	4.0	975	48.5
MAP	6	....	....	5.5	41	9000	....	......	......
MAR	12	....	....	11.0	45	10000	....	......	......
MAS	12	....	12-16	11.0	35	4100	6.0	440	20.0
MAU	12	....	42-53	11.0	65	4800	6.0	540	17.3
MAU	12	2:1	42-53	11.0	65	2500	6.0	535	35.0
MAW	6	....	42-53	5.5	65	4900	4.0	670	18.0
MAX	6	....	42-53	5.5	65	5300	4.0	880	25.0
MAX	6	22:14	42-53	5.5	70	3900	4.0	845	31.0
MAX	6	29:14	42-53	5.5	77	2695	4.0	906	45.9
MAY	12	....	42-53	11.0	30	5300	6.0	285	13.2
MAY	12	29:14	42-53	11.0	42	2500	6.0	260	22.0
MBA	6	....	42-53	5.5	65	4500	4.0	700	17.0
MBB	6	....	....	5.5	60	10000	....	......	......
MBC	12	....	....	5.5	35	10000	....	......	......
MBD	24	....	40-50	22.0	70	5800	6.0	590	35
MBE	12	....	38-61	11.0	....	6200	6.0	300	3.8
MBE	12	2:1	38-61	11.0	....	3500	6.0	300	8.4
MBF	12	....	....	10.0	22	4800	5.0	135	6.0
MBG	12	....	42-53	11.0	55	7300	6.0	375	9.8
MBH	6	....	....	5.0	40	6000	4.0	500	12.0
MBJ	12	....	....	11.0	65	6400	6.0	570	18.0
MBK	6	....	....	5.0	65	11000	....	......	......
MBL	6	....	....	5.5	60	5000	4.0	420	5.0
MBM	6	....	....	5.5	60	5000	4.0	420	5.0
ML	6	....	12-16	5.5	50	2980	4.0	750	26.0
ML	12	....	12-16	5.5	50	2980	4.0	750	26.0
MR	6	....	12-16	5.5	40	2800	4.0	700	43.0
MR	12	....	12-16	11.0	50	4300	4.0	700	43.0
MZ	6	....	42-53	5.5	70	4300	4.0	560	11.8
MZ	12	....	42-53	11.0	55	7300	6.0	375	9.8